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BY AUTHORITY OF
THE ROYAL MEDICO-PSYCHOLOGICAL ASSOCIATION

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“ In adopting our title of the *Journal of Mental Science*, published by authority of the *Medico-Psychological Association*, we profess that we cultivate in our pages mental science of a particular kind, namely, such mental science as appertains to medical men who are engaged in the treatment of the insane. But it has been objected that the term mental science is inapplicable, and that the term mental physiology or mental pathology, or psychology, or psychiatry (a term much affected by our German brethren), would have been more correct and appropriate ; and that, moreover, we do not deal in mental science, which is properly the sphere of the aspiring metaphysical intellect. If mental science is strictly synonymous with metaphysics, these objections are certainly valid ; for although we do not eschew metaphysical discussion, the aim of this JOURNAL is certainly bent upon more attainable objects than the pursuit of those recondite inquiries which have occupied the most ambitious intellects from the time of Plato to the present, with so much labour and so little result. But while we admit that metaphysics may be called one department of mental science, we maintain that mental physiology and mental pathology are also mental science under a different aspect. While metaphysics may be called speculative mental science, mental physiology and pathology, with their vast range of inquiry into insanity, education, crime, and all things which tend to preserve mental health, or to produce mental disease, are not less questions of mental science in its practical, that is in its sociological point of view. If it were not unjust to high mathematics to compare it in any way with abstruse metaphysics, it would illustrate our meaning to say that our practical mental science would fairly bear the same relation to the mental science of the metaphysicians as applied mathematics bears to the pure science. In both instances the aim of the pure science is the attainment of abstract truth ; its utility, however, frequently going no further than to serve as a gymnasium for the intellect. In both instances the mixed science aims at, and, to a certain extent, attains immediate practical results of the greatest utility to the welfare of mankind ; we therefore maintain that our JOURNAL is not inaptly called the *Journal of Mental Science*, although the science may only attempt to deal with sociological and medical inquiries, relating either to the preservation of the health of the mind or to the amelioration or cure of its diseases ; and although not soaring to the height of abstruse metaphysics, we only aim at such metaphysical knowledge as may be available to our purposes, as the mechanician uses the formularies of mathematics. This is our view of the kind of mental science which physicians engaged in the grave responsibility of caring for the mental health of their fellow-men may, in all modesty, pretend to cultivate ; and while we cannot doubt that all additions to our certain knowledge in the speculative department of the science will be great gain, the necessities of duty and of danger must ever compel us to pursue that knowledge which is to be obtained in the practical departments of science with the earnestness of real workmen. The captain of a ship would be none the worse for being well acquainted with the higher branches of astronomical science, but it is the practical part of that science as it is applicable to navigation which he is compelled to study.”—*Sir J. C. Bucknill, M.D., F.R.S. (Journ. Ment. Sci., vol. vii, 1861, p. 137).*

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Part I.—Original Articles.

WHAT THE PATIENT THINKS.

THE PRESIDENTIAL ADDRESS DELIVERED AT THE ONE HUNDRED AND SEVENTH ANNUAL MEETING OF THE ASSOCIATION ON WEDNESDAY,
JULY 7th, 1948.

By W. REES-THOMAS, M.D., F.R.C.P., D.P.M.

Senior Medical Commissioner, Board of Control for England and Wales.

I AM proud to have become your President for the year, and I trust that your confidence in me will be justified by events. It is with some regret that I step into the place of your immediate Past President, and I am not willing to do so until I pay my tribute to his work as President of the Association. Together with your Honorary Secretary he has carried the Association through a period of great strain: he has left it with an enhanced reputation for, I might say, charm and sweet reasonableness. That is in tune with what we preach, and accords well with the beliefs of most of us who know that Psychiatry has a place on the map, and it gives to us an assurance of its value to the world of mankind.

For us this is a period of change. The establishment of a new regime brings new ideas, and I believe we are entering into the hospital scheme with the knowledge that psychiatry is represented at every level.

This then is an opportunity to bring up certain aspects of hospital life on which there may be widely differing opinions. As medical men we agree generally on the arrangements required for patients who live for long periods in our hospitals, though I would point to differences of practice as evidence of varying degrees of attention to the ordinary daily life and occupations of the patients.

If we can for a while look at our hospitals as the patient (and his friends) must do, we will see it in a new light. For the patient the methods of purely medical treatment will appear vaguely as a series of remedies on which he

relies, and which he hopes the doctor will apply to him only in so far as there is need, or the absolute necessity. He will be more definite about other matters which are less clearly reserved to psychiatric medicine. Though less directly curative in character, the remedies are of vital importance to the patient, to his comfort, to his feeling of well-being, to his personality, and to his future prospects in life.

The willingness of the patient to come into hospital depends on many factors. How early he will accept the advice of the doctor depends on the strength of the links the doctor can forge. But strong as those links may be, the final decision must depend on the patient's view of the hospital to which he is offered admission. For him the question is: How shall I get on there, and, what sort of life shall I be compelled to accept?

We all know how difficult it is to answer these questions; we know that it rests on our view of the risks to which the patient is exposed. But the fact that they are so constantly asked clearly shows that life in a mental hospital presents a problem to the patient. It may be that he has preconceived notions based on reading and rumour, but without these aids to knowledge he has little means of knowing about the hospital and its work. If we could arrange the life and routine in such a way that even the mentally ill accepted it we should have done our job. We are doing our best, we are moving in the right direction, and year by year the term hospital is becoming a more appropriate description than asylum.

I would like now to mention in general terms some of the things which patients who have been in hospital have regarded as important to their general welfare and recovery. In acute hospitals for physical diseases the poor physical condition of the patient on admission and the rapid solution of the medical or surgical difficulties enable him to accept with gratitude other services and facilities which would in a mental hospital be entirely inadequate. The patients in mental hospitals stay longer, recovery is slower and our problems are correspondingly greater. The patient often does not recognise the less obvious means of promoting recovery; the separation from the social setting in which he has broken down is regarded as a hardship, and therapeutic occupation is sometimes described as work. They do not appeal to the patient as remedial in character, but such they are. I do not mean that the patient is expected to become merely a passive element in his treatment, but that he should be allowed to understand just what is the aim.

The maintenance of the normal life of the individual with his questioning mind should continue side by side with the mental illness, so that when recovery comes, social reduction and misunderstanding is not a serious problem.

If the patient does not respond to treatment and has to spend years of his life in hospital, it is still necessary to maintain for him a society in which the social activities are normal in character. He need never be left at the mercy of the unreal world. The tendency of the patient to travel with his mental illness rather than with his social self raises immense problems, for we all know that whenever he is allowed to sever his connection with the ordinary activities of life he deteriorates rapidly, and becomes an even greater burden of care and nursing.

There have been developments during past years which greatly ease the burden. Forty years ago mental hospitals were isolated institutions without any real contact with the community. The only person with outside obligations would be the medical superintendent, whose contacts consisted mainly of occasional consultations with medical practitioners in the homes of unfortunate but wealthy victims of mental illness. The hospital was regarded as a place to which patients were sent for the protection of the family or the public. On the standard of the day I would say the work was well done, for a close eye was kept on both the patient and the maintenance rate. The steadiness of the latter or even a slowly falling barometer of cost was a signal of skill, and, be it plainly said, this was used by some of our leaders, who should have known better, as an index of medical and administrative maturity. Those who belong to my generation will in these respects recognize the greater opportunities afforded to the generation of to-day.

And there has been another change which is of more general social character. Our people, in spite of a series of disastrous wars, have acquired new reactions to disappointment, obstruction and thwarting, whether arising from normal causes or from fantasy and delusion. In 1909 when I first entered a mental hospital it was a dangerous place. Reaction by physical violence was more frequent than it is to-day, probably in a ratio of about ten to one. I use these recollections merely to illustrate my point that changes in social matters have made possible an altered atmosphere in the hospital where advantage has been taken of the opportunities that time alone has brought to us.

I am not here concerned with the medical developments in the treatment of patients, but with the changes which the patient himself appreciates or would like to see in the general amenities of the hospital and of the supplementary aids to treatment. I will begin with the change in status. Since the passing of the Mental Treatment Act, 1930, patients have been admitted to public mental hospitals on a voluntary basis. This was something new, and indeed it has proved to be a most valuable piece of legislation. Not only does the patient enjoy the thought that he comes in and goes out of his own free will, but he is finding that more and more of his fellow-patients are there on the same footing. The establishment of out-patient departments, following the enactment of 1930, made it possible for our doctors to make contact with the patient before he comes into hospital. As a result, and for other reasons, the proportion of voluntary admissions has risen to an average of over 54 per cent., with a maximum of nine voluntary patients in every ten admissions.

In hospitals where the proportion of voluntary admissions is highest the standard of behaviour among the patients is very high too. Taken as a single fact observed, this has profound significance for the future of our hospitals. They are no longer places for the treatment of the socially impossible, but hospitals for the treatment of illness. I need hardly stress the effect this new outlook is having both on the patient and on the general public.

I come now to another ground for complaint. I call it a complaint because the patient forever puts it forward as one of the grave disadvantages of residence in hospital. Whether there is substance in the charge that limitation of

freedom goes beyond the needs of the particular case is not quite so relevant as the clear fact that the practice in different hospitals varies within very wide limits. The need for the fullest freedom which the condition of the patient justifies is accepted by all of us here. Indeed, there is growing up among us a generation of doctors who believe that treatment of a willing patient is the only road to healthy practice, and that there can be no effective approach when the patient is under detention. That is not a new gospel, but it shows once again the necessity for caution in applying compulsion where it cannot be shown to be essential. If the presence of delusions and the indulgence in phantasy were grounds for action, who would be free? The pioneer work of Rees and his colleagues at Warlingham illustrates the need for a new attack on the problem. They have developed a technique which is successful in providing freedom within the hospital and grounds for more than 90 per cent. of the 1,000 or more patients resident, and here we have a mental hospital which makes no selection of admissions, but covers the full needs of the area which it serves.

Under the circumstances it seems absurd to speak of parole; rather it can be regarded as normal practice to permit patients to move freely about the hospital. We need emphasize only the proportion of the patients which is confined by the locking of ward doors. The change in practice must of necessity be developed slowly, and we know that it is taking place in all our mental hospitals. Perhaps it is first necessary to lessen the intensity of the mental illness by dealing with it in the community clinics and in the home. In any event there is much satisfaction in the thought that within a few years the idea of a mental hospital as primarily a place of detention may be forgotten. I admit that in this I am a little idealistic, but the events which have already taken place show that we are on the threshold of new reactions. For the moment it is enough to say that the social necessity for "close" supervision is being examined. Increased freedom need not involve greater risk, but rather a recognition of social changes in the patients themselves. In this matter we cannot afford to fall behind, lest we be accused, as we sometimes are, of living in a small world of social unrealities. That charge is difficult to refute so long as evidence of it can be produced from a single hospital in the country.

As I am looking at this problem through the eyes of a patient I must add that here we have the means of developing for him a normal social life within the limits of the hospital community, the life which, rightly or wrongly, every patient expects us to provide for him.

But I have as yet shown you only a few details of the picture based on the impressions of a patient. The main detail relates to the period when he is not actually receiving medical attention from the doctor. With the large number of patients receiving treatment free time must of necessity extend through a good part of each day. The aids to treatment which are not clearly medical in character are often not recognized as treatment at all, and are, therefore, not so willingly undertaken. But in the absence of social and occupational aids, the patient complains of boredom beyond measure.

Happily the complaint is not confined to this narrow field, but applies equally to life in general. Shortened hours of work give greater leisure, but

the full beneficial effect to the individual is secured only when he develops social and recreational activities commensurate with his particular needs, and the standard of education (as against literacy) in this country is rising slowly, and in the new generation the increased school-leaving age will lead to more rapid progress.

I think we have to take note of this. When we treat our patients in hospital we shall need to provide occupation and entertainment at a level which their education and thinking justifies. I am not concerned here with the details of organization so much as the general principle involved. While the patient is sick we cannot expect him to do anything in the nature of full employment, but there will be some less arduous programme set out as part of the treatment of his illness. The weaning of the patient from the atmosphere of illness and of inertia or even of overactivity is a task requiring much patience and skill. Accepted disability with its social and economic dependence so commonly accompanies mental illness that I do no more than mention it. Even with a normal person the holiday which gives freedom from care cannot be too long lest the power to struggle through life is weakened. For the mentally ill the path to permanent idleness and social dependence is straight and short.

I have indicated the task, and I need hardly tell you that the struggle to lift the patient out of the slough of inactivity is being fought daily. The view that occupational and recreational therapy is an important part in the treatment is slowly gaining wider acceptance, though the means available to carry it out is limited by staff difficulties and shortage of materials. Often, too, the method of treatment is not rated high in importance. For the past hundred and fifty years the gospel of occupational therapy has been preached. That I am doing so to-day shows that we still seek converts. The earnestness with which this therapeutic method has been advocated shows that in practice at least it is not being fully used, and so it has been since hospitals existed. When in 1815 the Governors of Bethlem Hospital proposed to build the new Bethlem, they issued an advertisement inviting those who had an opinion on the subject to give it. Dr. Latham, a President of the College of Physicians, who at the request of the College had many times acted as Commissioner visiting places where lunatics were detained, made a statement before the Committee on Madhouses telling them his mind on the subject. He had recognized the need for supplementing the forms of treatment then available, and I suspect that he was talking to people who did not hold the same convictions.

The Commissioners of the College of Physicians sometimes did not approve of the standard of care and treatment available to the insane. In evidence given before a Special Committee, Sir Lucas Pepys, seven years President of the College, noted that when Commissioners of the College visited hospitals for lunatics they often arrived without notice in parties of three or five, who immediately split up to visit and examine the different parts of the hospital. Their attitude must be taken as indicating some concern for the welfare of the patients; and yet in his letter to the Governors of Bethlem Dr. Latham refers only to the need for providing occupation and diversion for patients undergoing treatment.

I give his statement in full because I feel that a quotation would not bring

out the extreme feelings with which Dr. Latham wrote on a subject which must have been dear to his heart.

“ HINTS RESPECTING THE GENERAL MANAGEMENT
AND EMPLOYMENT OF INSANE PERSONS.”

“ Having observed in the public papers an address, accompanied with proposals for the erection of a new Hospital for Lunatics, I could not refrain from throwing together a few ideas which I had entertained upon the subject ; for it has long been my opinion that the unfortunate persons, for whose benefit such houses have been constructed, might, under a more enlarged system, reap more extended advantages, than they at present receive from the very restricted mode of confinement now generally followed.

“ I have repeatedly been a Commissioner, appointed by the Royal College of Physicians under the Act ‘ For the regulating of Madhouses.’ In the execution of my official duties, I have always been struck with the decorum and propriety of behaviour which a single keeper has been able to maintain among the majority of the unhappy persons whose unfortunate condition has rendered their confinement necessary. The question on such occasions, which naturally presented itself, was, whether that management, by which such great decorum was produced in an assemblage of fifty or a hundred persons, might not be extended so as to provide some occupation also, which might be beneficial to the unhappy patients, and productive likewise to the Establishment. Reflect but an instant upon the situation in which a man must find himself, when, upon the least dawn of returning reason, he sees himself surrounded by objects under all the different gradations of mental misery ; and it will at once be conceded to me, that any thing, however trivial, upon which his faculties could then be exercised, might contribute in an incalculable degree towards his comfort, and consequently towards his speedier recovery. Consider too, the influence which the employment of the body possesses also over the mind, and it will readily be acknowledged, that something ought to be devised, by which the bodily strength of the patient might be made subservient towards its comfort and direction, at this most critical period of its weak and irregular condition.

“ It is a fact not to be controverted, that in those Asylums for Lunatics, where labour makes a part of the medical regimen, a greater number of the patients recover, than in those receptacles where, from the superior rank and opulence of the patients, nothing like bodily exertions are required ; and surely it must be a mistaken notion to suppose, when a disease has levelled to the same common standard the peer and the beggar, that one must be deprived of a remedy which is affording comfort, and perhaps a cure, to the other. For this disease is not like many other visitations of Providence, which may afflict a man, without destroying those consolations which are to be derived from his superior means and rank in society. But here the mind being equally lost in all, the man can feel no more actual gratification who possesses such distinctions, in reality, than the poor wretch who is constantly fancifying himself in possession of them ; for every thing is either false in

perception, or perceived to no salutary or proper purpose, by both of them. Why then can it be supposed that an establishment according to the rank of a person should be necessary, when from that very establishment it not unfrequently happens, that the source of the mental misery can be traced ; and why is the equipage of carriages and servants, sometimes indeed even *legally* authorized and allowed, when perhaps the privation of those most unnecessary appendages might constitute the first most important step towards correcting those ideas, on which the cure so very materially depends ? Painful indeed it is to see a man, devoid of all mental energy waited upon by a number of servants, supplied with all the luxuries of life, and carried about in his coach with all the accustomed pomp and grandeur of elevated rank ; who, had he but the least glimmering of reason, would tell you, that he derives not any enjoyment from such indulgences, which are habitual to him, and which cannot be otherwise than trifling and illusory when compared with such exercises as might call forth his bodily exertions, and along with them, in a more earnest and effectual manner, possibly engage his mind also.

“ On the importance, then, of some plan which may have for its object that sort of labour, which, by exercising the body, may occupy the mind also, I think there can be no doubt ; and I trust it may not be deemed too presumptuous in me, who have seen something of the arrangements necessary for Insane persons, if I offer my observations for the consideration of such as may be contemplating any new Establishment on a large scale. And first, then, I would observe to the governors of Bethlem, who are now about to build their new Hospital, that the site should be chosen with the full approbation of their intelligent physician ; that the plan of the building should combine utility with convenience ; that the *solitary* cells should be placed where the noise from the more furious Maniacs can least incommode those who are becoming more tranquil ; and that *these* should so be disposed, that their cells may communicate with small apartments, which will allow only of a few being associated together ; and where, as in an Infirmary, their general health, which often very materially suffers, may be more fully restored ; and where they may wait until that period when the medical officer shall deem it prudent for them to mix together in greater number.

“ But here unfortunately, the usual arrangements for Lunatics terminate ; for afterwards there is no diversity of occupation, but the same horrid spectacle constantly presenting itself to agonize the mind, which, in its then tottering and enfeebled state, cannot be supposed able to support itself, but must often sink again into that abyss of misery from which it seemed to have been emerging. Here, then, is the precise period when some pleasurable object should be presented to the mind, instead of those which are terrifying ; when its occupation should become amusing to it, and its pursuits rational. As this must be effected by finding an easy and proper employment for the body. A large and spacious gallery might be so constructed as to admit of various exercises in rainy seasons ; and when the weather was fine, the more innocent diversions might be allowed in an open court, which should be flagged throughout, and provided with little boxes for the patients to retire into, when, from the labour of fives, the hoop, or the skipping rope, the intendants should think it prudent for them to rest

themselves : For the patients should never be permitted to manage their own exercises, which might sometimes end in sudden tumult ; but should always be under the guidance of two or three keepers, each of whom, as a sort of ludi-magister, might on every occasion, be appealed to as the director and regulator of their sports.

“ But if a man can play, he has also generally strength enough to work ; and although he might be unequal to a full day of labour, yet his time should not therewith be altogether so occupied as to afford but little opportunity for amusement. Such an alternation of exercise as that which arises out of actual labour, relieved with play, would naturally arrest his attention ; and he would soon be collected enough in his behaviour, to shew that he was sensible of any little indulgencies which might be extended to him ; and which, in a well-regulated Establishment, would generally be at hand to be afforded him. Of all the different sorts of labour, I cannot be supposed capable of pointing out the most proper. A garden, I presume, consisting of a few acres, would supply the means of an almost endless variety ; for it might be so planned and appropriated as to admit of digging, planting, weeding, hoeing, wheeling, and everything else connected with horticultural labour and amusement ; and one part of it should be a bowling-green. The sawing of stone is another easy and most useful occupation : The manufacture of osier-work and of twine, and a variety of other safe and useful occupations would soon present themselves ; in many of which the female patients might also be employed, as well as in mending and washing and getting up the linen of the whole Establishment. But I will not become tedious, by enumerating the many matters from which might be derived benefit to the patients and advantage to the Institution ; since several of much importance would necessarily connect themselves with it, if conducted upon the enlarged scale which I have taken the liberty of proposing, and obtrude themselves daily, for the consideration of an active manager. Here, then, I will close my observations, with a hope, that what I have urged, under a conviction of its practicability, may some time or other be adopted, for the relief of the most deplorable malady that can possibly afflict mankind.”

Need I say much more about occupational treatment ? He makes his case as I could not do. I add to his plea now only because the patient is demanding that something must be done about his idle days in hospital. We on our part know that we have in our hands a form of treatment which not only helps to cure the patient, but also fills the daily life of the patient with interest in familiar and unfamiliar activities and recreations, for which service they will bless your name.

I have outlined certain definite aims. I have made no attempt to cover the field of treatment, but merely to tell you how the problem has been regarded by your patients. They do not understand our legal formulae, they do not know what we know about leucotomy, insulin treatment, electric multi-therapy. For them these represent only periods of lost time—complete unconsciousness. But they do for ever remember the lack of freedom, the acts of detention and the devastating boredom of an idle and uninteresting life in hospital.

I think we are pressing forward with our new point of view. The need for detention is becoming less and less apparent, and in time will apply to only a small proportion of our patients. I think we must be careful lest the desire for a form of temporary treatment, which puts into our hands a simple way of enforcing detention for a limited period, does not result in diverting us from the supreme task of making our hospitals places to which patients will come willingly for treatment. Freedom is here as elsewhere the only sign of greatness in human relations, and this to my mind should be our aim.

I want to refer very briefly to one of the inevitable consequences of the "new look" in mental hospitals.

The buildings were not put up for purposes such as we now have in our minds. Excepting for a few of the more recently built admission hospitals and villas the wards were designed to deal with certified patients, and are to-day quite unsuited to the multiple purposes for which in any active hospital the rooms must be put. The ancillary buildings for occupational, educational and recreational activities are entirely insufficient for the job. The treatment of mental illness is an important and absorbing business. The form of treatment which has for its aim the rebuilding of the patient's mental life cannot be operated satisfactorily in the absence of a place in which it can be carried out. Recent developments in practice press the need for smaller and different ward units, and a greater range of small buildings for occupational, social and recreational purposes. Just now we must do the best we can with the material at hand, with patch-work additions here and there.

But for new hospitals, new planning will be needed to provide for the daily life and treatment of the patient. I think it will in many respects be a new kind of hospital—one which is not centred on the large ward unit and the colossal recreation hall. Many of you are thinking about it. Group opinions should be available, so that the united experience of a number of medical men could go into the building of any new mental hospital.

Few of us are bold enough to stand alone and to demand the new forms of buildings which inevitably will add greatly to the cost. As a group we may be strong enough to express a clear view of what is needed, both to provide the doctor with what he wants, and to give the patient and his personal needs a place in the living hospital.

MORALE AND FLYING EXPERIENCE: RESULTS OF A WARTIME STUDY.

By D. STAFFORD-CLARK, M.D., M.R.C.P.

[Received 27 August, 1948.]

FLYING STRESS.

COMPARABLE with the misconceived diagnoses of shell shock (1) and D.A.H. (2) which were current in Army practice in the World War of 1914-18 were the terms Flying Stress (3), Aviators Fatigue (4), Aviator's Neurasthenia and the American Aeroneurosis (5), of aviation medicine. With all, a convenient label covered unjustified assumptions about pathogenesis.

Symonds (6) has dealt succinctly with the ambiguity of the term Flying Stress. He succeeded in establishing its only permissible use as a description of the stresses to which the flying man is liable rather than of the reactions which he displays. It is with the nature of the particular stresses involved by the operations of Bomber Command, and their effect upon the men who were called upon to endure them, that this paper is concerned.

During the war the Command consisted in a central organization controlling a number of groups of advanced training and operational stations. On each of these stations were operational aircraft, twin-engined or four-engined. Members of aircrew selected for duty in Bomber Command were posted to their advanced training stations in the Command for final flying training and for welding into a crew; at the time of their arrival the pilots had completed an average of 200 to 250 hours flying, the other members of the crew between 30 and 100 hours in the air. At their operational training unit, abbreviated in description to O.T.U., they met together and were made up into separate crews, each of which from that time onwards would remain as far as possible united, on and off duty, until ultimately their operational tour was completed.

This conception of the solidarity and integrity of a crew begun and fostered at this stage of the men's flying career, was a tremendously significant influence in their lives and their attitude to their job. The fundamental and insistent need which all men have, to identify their greatest efforts with something beyond and bigger than themselves, found here a temporary expression. A good captain's concern for his crew, each individual member's sense of obligation and responsibility towards the whole was more than simple comradeship, more even than comradeship tightened and tempered by war, with its shared perils, terrors, and experiences; it had become an act of faith.

These crews, newly formed, spent then a period of one or two months in training by day and night for operational flying against Germany and occupied Europe. They attended lectures, were drilled in the technique of meeting emergency in the air, and of fulfilling their complicated tasks in the face of

every conceivable hazard or handicap ; they were taught how to abandon their aircraft in the air or on the sea after forced descent, if so compelled ; they undertook cross-country flights in darkness and daylight at operational heights with full use of oxygen and protective clothing, until they were judged competent to take their place among the operational crews in squadrons actually flying against the enemy from neighbouring stations in the Command.

At this stage the crew would consist of five men ; the pilot, who was in addition captain of the aircraft, and who bore the ultimate responsibility for all decisions during flight, the navigator, bomb aimer, wireless operator and rear gunner. But before this nucleus of a trained operational crew could join a squadron in the later years of the war, they had to complete their preparation by conversion from the twin-engined operational training bombers, to the four-engined heavy bombers in which their operational flights would be undertaken. This involved a further two to four weeks' training at a conversion unit, where two more members, a flight engineer and mid upper turret gunner joined the crew. The flight engineer was primarily responsible for the care of the engines during flight, and apart from his initial flying experience which might vary between an hour or two in the air to 30 or 40 hours as a passenger, he was characteristically far less accustomed to flying as a background to his activities than were the rest of the crew.

Before leaving the conversion unit the crew undertook a final series of full scale rehearsal flights for operations ; these included night flights as exercises over London and industrial England, over the sea, and sometimes over the less heavily defended areas of occupied Europe. These approximated as closely as possible the actual operational sorties ; when they took place over England opportunity was taken to include full scale night fighter and searchlight exercises over the cities upon which the dummy attack was planned. Several hundred bomber crews in the final stages of their training would be briefed for such an exercise and take part in it.

Their training accomplished, the crew were finally posted to an operational squadron. Here they remained until they had completed a tour of approximately thirty operational sorties, or had been killed, wounded, or taken prisoner in the attempt. A single completed sortie or mission was reckoned as one on which the crew had reached and bombed the primary target, or if that had proved absolutely impossible, had identified and bombed an approved secondary objective. Only in exceptional circumstances, as for example when weather conditions precluded sufficiently accurate identification of a target in occupied Europe to justify the bombing, was return from a mission without attacking the objective permitted to count as a completed operation towards the full tour.

Before 1944 the vast majority of heavy operations by air crews of Bomber Command were undertaken by night, at heights between 15,000 and 25,000 feet, involving temperatures between -15° and -45° C., and necessitating the continuous use of oxygen breathed through special masks by each individual member of the crew. They lasted usually between three and eight hours.

Preparation for a particular trip began, for the air crew concerned, with the preliminary briefing for captains, navigators, bomb aimers, and wireless

operators, when the target and the nature of the operation together with the detailed technique to be employed, was explained. Later came the operational meal followed by the main briefing for all crews some three and a half to four hours after pre-briefing; then all men dressed themselves in their flying clothing and were driven out to their aircraft about an hour before the time set for taking off. At any stage during these preliminaries the operation might be cancelled, postponed or altered, necessitating further briefings or a period of standing by, during which no one could be certain whether the operation would finally take place or not. Such alterations, cancellations and delays are inseparable from war—or indeed from any form of organized planning dependent on circumstances beyond the control of the planners.

No one who saw the mask of age which mantled the faces of these young men after a period of continued standing by punctuated by inevitable false alarms, is likely to forget it. Their pallor, the hollows in their cheeks and beneath their eyes, and the utter fatigue with which they lolled listlessly in chairs about their mess, were eloquent of the exhaustion and frustration which they felt. In ten hours they seemed to have aged as many years.

After a long and exacting operational flight similar evidence of fatigue, both of body and mind may display itself. But in this case there is no element of frustration; the emotional hangover is far less; and because tension has dissolved in action, sound sleep may be expected to restore resilience in all but those who are already in need of medical assistance. This assistance must be based upon a reasoned appreciation of the situation prevailing in any particular case—an appreciation immensely facilitated in practice by an understanding of the fluctuations to which morale was normally subject during the various stages of the operational tour.

On return from an operation the crews were interrogated by intelligence officers, gave their reports, had breakfast and went to bed. Any returning wounded, shocked or in any way requiring medical care and attention, received it on the spot, being admitted to the Station Sick Quarters or to Hospital, after resuscitation if this was their need. But quite apart from this then Medical Officer was always present at briefing, mingled with them in the dressing rooms, advising them about measures to prevent frost-bite, to deal with frozen oxygen masks, to maintain alertness, and to overcome thirst or exhaustion. On their return he spent his time between the airfield and the interrogation room, meeting each crew as they landed.

In this way he was able to exercise a continuous motivative supervision over each one of them and they in their turn came to know and to trust him as someone always associated with their efforts and unfailingly on hand whenever they might want him. This was the foundation of his work for them, providing him with his experience and them with their confidence in him.

A crew did not as a rule operate on two successive nights, although during phases of operational urgency this might be necessary—for example during the Battle of Berlin from December to January, 1943-44, some crews bombed Berlin three times in four nights. But it was more usual for a crew to make an average of about three to four operational sorties a week with an interval of one or two nights in between.

What were these operations like ? They were like nothing else in the world. The air crew flew in darkness relieved only by the dim orange glow of a lamp over the navigator's table and the faintly green luminosity of the pilot's instruments, three or four miles high, through bitter cold over hundreds of miles of sea and hostile land, with the thunderous roaring of the engines shutting out all other sounds except when the crackling metallic voice of one member of the crew echoed in the others' earphones. For each man there was a constant awareness of danger : danger from the enemy, from sudden blinding convergence of searchlights accompanied by heavy, accurate and torrential flak, from packs of night fighters seeking unceasingly to find and penetrate the bomber stream ; of danger from collision, from ice in the cloud, from becoming lost or isolated, from a chance hit in a petrol tank leading to loss of fuel, and a forced descent into the sea on the way back, if nothing worse. There was no single moment of security from take off to touch down, but often the sight of other aircraft hit by flak and exploding in the air, or plummeting down blazing to strike the ground an incandescent wreck, even when a crew's own aircraft had escaped attention. These were familiar aspects of the flying man's experience. To these he had to adapt himself so that he could eat, sleep, read, work and play, not unaffected by them, for that would be impossible, but undefeated by them (7). The average rate of loss over this period was officially assessed at 5 per cent. on each operation, but this referred in fact only to aircraft which were missing. It did not include crashes in the United Kingdom, either on take off or return, whether due to the normal hazards of flying or to enemy action. In practice the chances of any particular individual surviving his 30 trips alive, unwounded and without having been taken prisoner, or having been forced down over enemy territory were generally accepted by the air crew themselves as being just about one in five.

This then was the basic ordeal confronting the flying man in Bomber Command. Faced with such an ordeal, it was inevitable that there should be a certain proportion of men who became unable to sustain it. From the point of view of combatant service they had to be divided into two main groups ; those whose inability to continue was not primarily medical, but was the expression of an innate reluctance which dominated their reaction to further flying ; and those whose actual medical fitness to persist had become impaired by the conflict between excessive fear and sense of duty, or desire to fulfil the standard of war service for which they had volunteered. This conflict was of course, to a large extent universal ; but among those in whom it precipitated a breakdown in morale and mental health, the reactions encountered varied in precisely the way that men's reactions to conflict normally do vary. The types of mental illness displayed by such men corresponded to those already familiar in civilian life. There were anxiety states, hysterical reactions, depressions, fatigue states and less commonly obsessive compulsive reactions.

Anxiety states were by far the most common ; hysterical reactions, while considerably less frequent, tended to arise more often in men whose reluctance to persist was more closely related to a lack of will ; men who, with more insight, would never have become medical cases at all although their reluctance would not by this have been diminished. Depressions, often coming on top

of continuous anxiety and suppressed fear, deserved particular attention. Such men were apt to blame themselves, to call themselves cowards quite unjustifiably, and in some cases risked being accepted by their executive superiors at their own valuation, with consequently hardship and injustice, to say nothing of loss of their highly trained services if they were dismissed from flying as unwilling to continue before the nature of their disability and its comparatively good prognosis had been fully recognized.

The importance of a sound initial approach to all these cases was beyond question ; men unnecessarily referred away from their own unit for a second opinion were affected by this very action ; some being alarmed by the implied seriousness or complexity of their problem, others seeing in this the confirmation of their half formed suspicion that their case was unique. In every case where uncertainty about a case hampered the Unit Medical Officer it harmed the patient.

The writer, for eight months a squadron medical officer to an operational medium bomber squadron, and for three and a half years senior medical officer to a heavy bomber station, attempted during this period a careful study of the general attitude of the aircrew to their job, with particular reference to the relationship, if any, which might exist between morale and flying experience; between reaction to flight and stage of tour reached or degree of stress sustained. This was supplemented by an analysis of every case of doubt, hesitation, or complaint of whatever kind connected with flying by a member of aircrew, seen on the Station.

Investigations into the relationship between morale and other factors such as predisposition, domestic anxiety, or other non-flying stress, had been or were being undertaken by other workers. A most valuable and authoritative comparison between the relative degrees of flying stress imposed by operations in Fighter, Bomber, Coastal and Transport Commands as evidenced by the reaction of the corresponding groups of aircrew was subsequently completed by Symonds and Williams of the Aircrew Research Detachment at Oxford, and incorporated in the Croonian Lectures for 1943 (6, 8). But the problem which claimed the particular attention of the author and which the performance of his Service duties gave him full opportunity to study was the influence of the cumulative stresses of operational flying upon the morale of the individual concerned, and the extent to which this might be offset by the increasing skill and confidence of experience on the one hand, or reinforced by the mounting fatigue of continued emotional tension on the other ; finally, the degree to which morale could be sustained despite these depredations by any means at the disposal of the unit medical officer or squadron commander.

A STUDY OF MORALE.

There were two aspects to the study of morale among operational aircrew : the first the basic attitude of the men to their job ; the second, the changes which that attitude underwent in any particular man during the course of his final flying training and his operational tour. By living with the crews, enjoying their confidence, and by flying with them, a subjective appreciation

of both aspects could be obtained ; an appreciation not based simply upon patients, but deriving also from the majority of operational aircrew of the writer's acquaintance, who at no time exhibited a psychopathological reaction to the stresses of flying, but whose remarkable courage and equanimity emphasized for him the degree of adaptation to a totally unnatural existence and expectation of life of which successful aircrew have to be capable.

During the early part of the war there was a tendency to regard the flying crews of the R.A.F. as dauntless dare-devils, thirsting for action, undeterred by odds. This was not accurate. An apparent wildness and irresponsibility were occasionally displayed by some men during periods of leisure as a deliberate indulgence, but were by no means universal, whereas on the job for which they had been trained they characteristically displayed shrewd judgment, responsibility and determination.

Not one man in a hundred looked forward to an operation with relish although most of them derived considerable satisfaction from doing an operation well and returning safely. On return one pilot, distinguished both by his courage and his acceptance of reality, described his feelings as "on waking from a bad dream" ; all that most aircrew wanted after furnishing their reports was breakfast and bed and sleep. They did not remember vividly every detail of all their operations, but they were conscious of no urgent desire to forget them.

Everyone looked forward to the completion of his tour, but so strong was the crew spirit in Bomber Command that it was not an uncommon occurrence for a man to volunteer to do as many as 10 extra trips so that he and his crew could finish together, if for any reason he had joined them with more to his credit than they had done.

Their attitude to losses and the death of friends was particularly striking ; it was one of supreme realism, of matter of fact acceptance of what everyone knew perfectly well was inevitable. They did not plunge into outspoken expression of their feelings, nor did they display any compromise with conventional reticence about the fact of violent death. They said "Too bad . . . sorry about old so-and-so . . . rotten luck" ; their regret was deep and sincere, but not much displayed or long endured. They were apt and able to talk of dead and missing friends, before mentioning their fate, just as they talked of anyone else or of themselves (8). It took the loss of particular friends or leaders, flight commanders or squadron commanders to produce a marked reaction among a squadron. Then they might feel collectively distressed, have a few drinks because of that, go on a party and feel better. But they made no effort to escape the reality of the situation, nor was there any of the drinking to forget referred to in accounts of flying in the last war. They were young ; they were resilient ; they lived until they died.

Their reaction to the popular conception of the R.A.F. was one of amused contempt. A caption in a daily newspaper in 1941, "Do we fly low, do we ?" parodying a popular song of the time, excited only derision among the aircrew who had actually flown in low level attacks on shipping and ports. The majority enjoyed adulation like most other people, but as they did not enjoy the risks of burning or maiming or violent death any more than anyone else,

they resented what seemed occasionally to be a tacit assumption by the public that they were so effortlessly gallant and irresponsibly "devil-may-care" as to be insensitive to all but the immediate present and indifferent to their own ultimate fate.

This, however, applied much more to the situation in 1941-42 than to that prevailing among the later years of the war. They were never completely unconcerned about their fate. They knew their job was highly dangerous and never was that knowledge far from consciousness. A moving example is given by this conversation between a squadron leader, D.F.C., and a senior flying officer, both of a Blenheim squadron, at about 6.30 p.m. one evening in 1941:

F/O.: "What do you think you're going to do after the war, Eddie?"

S Ldr.—gazing thoughtfully into the bottom of his glass—"Oh, I don't know. I don't really think I shall last as long as that."

This was said quietly, matter-of-factly, and sincerely by a sound, intelligent man of a calm and cheerful disposition.

Another effect of the constant awareness of uncertainty whose detailed consideration would demand the space of another paper was the mushroom growth of superstition among the aircrew. Personal mascots, ranging from hare's feet to girl's silk stockings were taken very seriously. A young W.A.A.F. officer who had lost two men friends in succession, both on operations, developed an acute depression with considerable feelings of guilt in response to the rapidly accepted verdict among the rest of the squadron that she was a jinx and carried "the kiss of death." This was not a grim joke; it was an even grimmer belief, sincerely held; one Captain of Aircraft, a Flight Lieutenant with D.F.C. and bar, going so far as to forbid any member of his crew to take her out, on pain of expulsion from the crew. There was no point in adding to the risks, he said.

This wide acceptance of a primitive system of magical ideas by men whose duties made them familiar with some of the most highly developed scientific apparatus at that time in use, was an ironic comment upon the materialist illusion of inevitable progress.

The attitude of non-commissioned flying crews differed from that of their officers in that they more frankly expected privileged treatment and special consideration. They were rightly encouraged in this by such concessions as special rations, vitamin extracts to supplement their diet, ultra-violet irradiation and extra leave; these were enjoyed of course by all aircrew, officers and N.C.O's.

But except in the air, N.C.O's. were more inclined to be resistant to discipline than officers. In this connection it must be admitted that there was a very small but definite proportion of Aircrew Sergeants who differed completely from the rest of their colleagues. Their motive for joining was simply glamour and promotion, their attitude to flying and its risks unconsidered. Most of this minority were air gunners or flight engineers, neither of whom have usually had the same degree of preparation or length of training, or been selected with as much attention to suitability of temperament as the other members of the

crew. The educational standard required in their case was correspondingly less exacting. Such men provided the bulk of cases displaying low morale in a squadron, and they were fairly characteristic. They lacked the conscientiousness, integrity and responsibility of their more impressive colleagues so that they were apt to claim operational successes (for example targets hit or enemy aircraft shot down) which they had not achieved. They lacked self-respect, and so their discipline was bad and their standard of personal cleanliness was often indifferent. Their mental attitude was often surprisingly adolescent and immature; off duty they pictured themselves rather as cinematograph heroes than as the men they were, attempting a most exacting job in this very real war. But, as has been stressed above, they constituted a small minority.

The foundation of this attempt at an appreciation of aircrew psychology was laid in 1941 (7): at this time the conception conveyed to the public mind from all available sources of information of the attitude of aircrew to their job lacked understanding or imagination. This was perhaps because the public were assumed to want their heroics simplified; subtlety might suggest fallibility; so despite all popular acclaims, propaganda about the R.A.F. tended to misunderstand and underrate the quality of their courage. The core of this quality, now more widely recognized, its most terrible and unforgettable characteristic, was the subordination of the instinct of self-preservation to an endeavour to fulfil a very high standard of war service; a determination to see the job through despite the greater love for wife or child or for life itself.

This was reached by deliberate decision; by intellect rather than by emotion, maintained by will, not by recklessness. It was in most instances an adult and considered choice—a vindication of self-respect and of dedication to a tradition of courage.

An understanding and sensitive appreciation of this was essential to the physician responsible for these young men; it was in fact a most necessary part of his clinical equipment. He had scrupulously to eschew the insidious fiction that flying men are intrinsically less vulnerable to acute misgivings and apprehension than their fellows in less arduous occupations; and a grasp of both their personal attitude and of the changes which it was likely to undergo during their tour of operations, was as invaluable to him in the treatment of those who, faltering, turned to him for help, as it was indispensable to him in the decisions he was called upon to make about those who could no longer continue. These decisions covered not only prognosis and disposal of medical cases; but also the distinction which had inevitably to be made between the medical and non-medical case; the man who was unfit and the man who was unwilling. It was no part whatever of the medical officer's duty to indict a man whose reason for ceasing to fly was not medical, nor did he pronounce judgment; but he could not evade his responsibility for giving an honest opinion in an expert capacity whenever this was requested. And in the Royal Air Force a medical opinion is required in every case of failure or refusal to persist with flying duties.

The second aspect whose importance became increasingly apparent was the effect of experience of flying stress in producing fluctuations in morale, which in turn determined both the type of man most likely to succumb at any particular

stage and the reaction he would probably display with its corresponding prognosis.

From the beginning the decision to volunteer for aircrew duties implies an acceptance of risk. The precise nature of this risk is rarely fully understood until actual flying begins, and then its perception may be gradual and cumulative or sudden and catastrophic, depending upon whether or not the airman experiences a crash himself or sees one involving men he knows well at an early stage in his training. This happens in a number of cases ; flying is one of the few activities where training and preparation exact a casualty rate comparable with that of combatant service. From the very beginning the experience of flight is apt to be disturbing as well as novel and exciting and interesting. Armstrong (9), dealing with both civil and military aviation in his book devotes considerable space to an analysis of the factors contributing to emotional disturbance in flight, quite apart from the risks of combat ; they include :

(1) Labyrinthine, visual and auditory stimuli of a most unfamiliar kind ; sometimes mutually contradictory as when in rough air violent sensations of rocking and rising and falling are accompanied by comparatively little observed motion of the horizon.

(2) Visceral disturbances such as nausea and vomiting (which may themselves be partly psychogenic in origin).

(3) Psychic disturbances, such as a feeling of acute apprehension, consciousness of height, and sense of insecurity and potential danger.

To these may be added :

(4) The discomfort of cold and the necessity for additional oxygen, indispensable at altitude. Both these factors introduce in their turn the necessity for wearing bulky and restrictive clothing and unfamiliar respiratory masks.

The normal individual rapidly accustoms himself to these experiences and to a varying extent may become almost unconscious of them. It is, however, interesting to note that, contrary to popular belief and the experience of those whose flying has been limited to one or two trips, totalling perhaps less than fifteen hours altogether, the sensation of vertical height anticipated before flight by the novice, and strikingly absent during his first few hours of flying (Armstrong (9), p. 463) tends to return as experience is gained, sometimes with profoundly disagreeable intensity. Naturally, the degree of emotional tension produced by this varies very considerably ; it is not usually great or troublesome, but it may occasionally obtrude into consciousness during flight, as for example when flying high above the ground, but comparatively low above a level of cloud which completely obscures the underlying view. On such an occasion the airman may be conscious of a sudden sense of visceral constriction as the aircraft sails out over the edge of the cloud bank, " as though he were driving over the edge of a cliff." This is cited, not as evidence that such an awareness of height is normally a serious strain upon the flying man, which it is not, but as an indication that the subconscious emotional tension of flight may be affected by this, as by other better recognized elements.

Later on in training, bad weather, the experience of being lost, or of running short of fuel, and the almost inevitable shock of flying accidents involving others

on the course, all add to the latent stress. But the time is approaching for the commencement of operations, and eagerness and a desire to find out what it is really like provide a strong counter support for morale. In a squadron the critical test of the man's whole career begins. For this he has been selected, trained, become perhaps a member of a highly interdependent crew, and from this point on there can be no voluntary turning back without dishonour, or at best a great loss of self-respect. He is keyed up, emotionally tense, eager but apprehensive, conscious of the comprehensiveness of his training and preparation, but fully alive to the dangers it was designed to meet ; then he begins.

His first two or three operational sorties are so full of novelty and amazement, however intelligent and imaginative his anticipation of them may have been, that unless he is fundamentally unsuited to operational flying he will not suffer from actual fear to a very great extent ; but by the time he has completed five to eight sorties he will have discovered to a large extent the magnitude of the task he has undertaken. By this time he has probably seen another aircraft shot down—perhaps followed its course right down to its final explosion on the ground, and seen some, but not all, of the crew escape by parachute ; or watched it fall burning, without a single man getting out. The extreme novelty of operational sortie has gone ; to be succeeded by a growing recognition of the cost. Symonds, in his Croonian Lectures (8) summed up admirably the mental state necessary to enable a man to continue his tour of operations through this and succeeding stages. He called it confidence and assessed it as a blend of resolution, bravery and fearlessness ; the latter quality depending partly on temperament, partly upon the sureness of good aircraft, good training, and sound organization behind the planning of the operation. He argued that the smaller the margin of fearlessness, the greater the dependence of the individual upon his resources of courage and determination to sustain his morale and ward off breakdown.

In all except the very few, confidence is bound to undergo fluctuations throughout the operational tour with a tendency to ebb with the passage of time, as the element of fearlessness becomes lessened by experience of disaster and by the exhaustion of continued emotional strain. None the less, immediately after beginning a tour there is a perceptible rise in morale ; this is due to the feeling of accomplishment and maturity now that the long months of training are left behind, and to the novelty, excitement and interest of this final stage of experience and adventure. By about the fifth sortie this surge in morale has begun to give place to the recognition already mentioned of the formidable reality of the tour. This tends to continue, in some cases almost subconsciously, until by the twelfth or fifteenth sortie the man has reached the stage in which the full realization of the danger and unpleasantness of the job has been forced upon him while there stretches in front of him an ominously large succession of repeated sorties before he can achieve the honourable completion of his tour. Indeed, while seeming more desirable than ever before, this now appears so remote as to be an unprofitable and almost impractical goal on which to pin his hopes. At this point his chances of survival are bound to occupy his mind to a greater or less extent, depending upon his commitments,

domestic situation, and temperament, and at this time they must appear at their lowest ebb. He is passing through the critical phase of his operational tour, and he has probably never been so consciously close to death in his life before. This is a realization that lives with him in the background of his mind all the time during these days, and he sees it reflected in his friends in the Squadron and in inevitable losses among them. Siegfried Sassoon, writing of a different aspect of war—the infantryman's—has none the less captured this exactly :

“ We are all near to death ; but in my friends
I am forewarned too closely of that nearness.”

The general life of the Mess strikes a strange contrast. Other people, non-flying or non-operational people, may be heard to talk of “ next month—when I go on leave . . .” or “ Christmas,” or “ Easter,” with reasonable confidence, and the tacit assumption that to plan ahead with some degree of assurance is nothing strange. But for the operational flying man that might be a waste of time ; time present and actual before the next trip, which is the only time of which he can be certain. Next week may be too far off for him. His next leave forms a focal point in his existence beyond which he probably does not choose to look. This is not to say that he is necessarily consciously unhappy or apprehensive all the time, nor that he lives deliberately for the minute, as airmen in the 1914-1918 war were said to live. It is simply an indication of the degree of emotional tension by which he is bound, and the background to his conception of his existence which this particular situation has created. All this his unit medical officer must understand if he is to be of any value to the flying man.

As his total of completed sorties mounts up (if he survives), the end of his tour gradually comes into the sphere of his permitted expectation and the average aircrew member looks forward to this with unconcealed eagerness. Later—after a period of rest and change—he will be again ready and keen to resume operations ; but for the time he longs to achieve a satisfactory completion of the tour. As this prospect increases and his wisdom, experience and confidence deepen, his morale rises steadily ; he is over the worst of it. But by the 25th trip the cumulative stress and resultant fatigue begin to tell in all but the most exceptional cases, and at any time from then onwards his C.O. may wisely decide to suspend his tour. None the less, by far the majority of aircrew who survive a tour complete their full quota of 30 operational sorties.

An attempt to illustrate all this graphically has been made in the accompanying diagram (Fig. 1). It must be emphasized that the graph is purely indicative of the fluctuations referred to above, and that no mathematical assessment of morale in terms of units is proposed or intended. Nor, indeed, could it be justified. It is, however, necessary for a clear illustration of the cumulative effects of stress, as described, to be given in order to link these with the incidence of breakdown at corresponding stages of the tour. The vertical axis of the graph is intended to provide an index of morale, based upon confidence in the sense used by Symonds (8). The horizontal axis is graduated in numbers of operational sorties completed by bomber crews. The curve is the index of the confidence of the individual concerned during the course of his

tour ; the upper horizontal line is the critical level for morale. If morale falls below this line the man can no longer undertake operational flying. Since this level does exist in every flying man, although it may vary widely from one to another and is anyway not statistically measurable, it may be drawn as shown, at a purely arbitrary level on the vertical axis, which is itself, as previously explained, an essentially subjective conception. By following the curve of morale from left to right one may acquire a mental picture of the reactions of the individual to the stresses of operational flying just described.

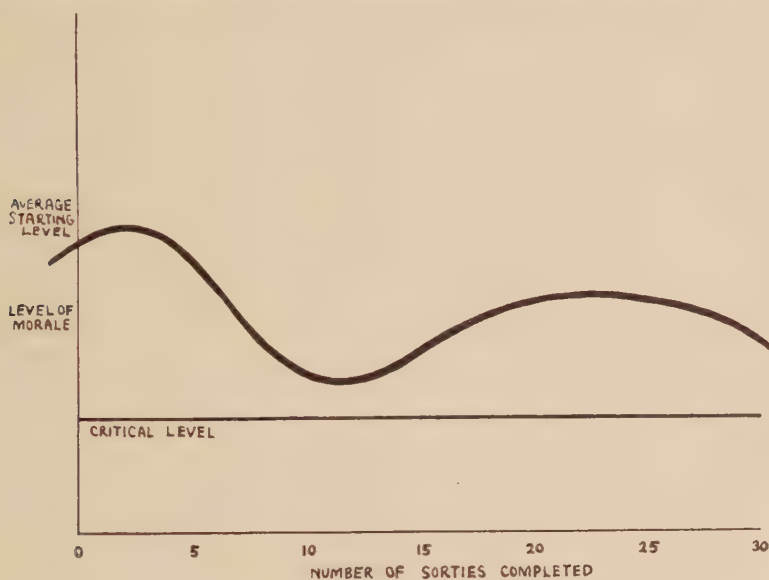


FIG. 1.

THE MECHANISM OF BREAKDOWN.

All that has been written so far applied generally to the great majority of operational aircrew in Bomber Command. The particular problem raised by the small percentage of men who broke down demanded special consideration.

Reaction to flying stress was an inevitable psychological response in every individual. In the vast majority of flying men it remained within limits which did not effectively diminish the man's capacity to perform his duties in the air and on the ground. It was only when actual interference with his efficiency as an airman occurred that the reaction was considered pathological. What began purely as a difference in degree was apt to end as a difference in kind. But in practically every case the responsible stresses were the same, and it was in contemplation of their nature that the first essential difference between the problem of civilian and aircrew became apparent.

It is the emotional reaction which underlies the production of symptoms in an anxiety state. The prolongation of these symptoms and their apparent association with stimuli which are not ordinarily associated with emotion, often characterizes the condition in the civilian patient. That symptoms may be produced by the operation of a conditioned reflex of whose associations the

patient can, and often does, remain remarkably unaware, is generally accepted. Among civilian patients insight into the precise cause of their development of an anxiety state is relatively uncommon ; but this was not so of flying men in time of war. For them the provocative stresses were nearly always so obvious as to be inescapable ; the conflict between duty and desire, self respect and self preservation, broke through into consciousness, leaving the patient bewildered, worried, and unhappy, but only too well aware of the reason. This was at once a striking and significant characteristic of these cases. But in treatment this insight was far less helpful for them than it would have been for a peacetime civilian patient, because it was not so much the symptoms as their cause which worried them. The airman did not dread flying because, when it was in prospect, he could not eat or sleep. He could not eat or sleep because he dreaded flying ; and this he nearly always knew. Moreover, such knowledge only added to his distress ; it did not diminish it. This did not mean that he was not helped by a sympathetic discussion of all his symptoms with a view to their evaluation. He usually was, and his gratitude and appreciation were sincere. But even more did he appreciate a full understanding of the strain which had fostered them ; and it was by reinforcing his own capacity to meet this strain that the physician helped him, when he could.

The flying man's problem might or might not be complex ; it was bound to be vital and acute. He might or might not be married, his wife might support or undermine his resolution by her attitude to his job ; he might have financial worries or aged parents dependent upon him, but one over-riding consideration inevitably underlay his development of an anxiety state as a reaction to flying. This was the natural instinctive fear of death, of maiming, of burning, or of becoming a prisoner ; the violent and overwhelming disaster or chain of disasters that wait upon all those who fly in time of war. There are many aspects of this tremendous factor which must be separately considered. But stripped of all less vital associations, this outstanding emotional strain confronted the airman inescapably. The neurotic patient may exaggerate or shirk his difficulties ; he may over-value the objects of his ambition or dread unduly the possibility of failure ; but the physical realities of violent death, mangling or incineration are sufficiently vivid for the most balanced imagination, once they have been brought home, as sooner or later they were bound to be brought home to all who flew on operations or in preparation for them.

Under peacetime conditions in addition to discussion and evaluation of a patient's symptoms, with the object of providing insight and understanding, the therapeutic approach to his problem may well include attempts to adjust his environment to his needs, as far as possible.

In the case of the airman the conflict admitted of no comparable solution. It was not in the doctor's power to mitigate the severity of stresses involved in operational flying ; nor was it any part of his job to diminish his patient's valuation of life or physical integrity. The conflict was between a very real dread based on a very real hazard on the one hand, and a sense of duty, of dedication to a pledged endeavour, and self-respect on the other. No one could honestly discount the first nor discredit the second ; nor has anyone any right to attempt to do so. The physician's task in such a case was quite unlike

that imposed by the civilian patient ; and there was a corresponding difference in the primary goal at which it was his duty to aim. In all cases this was of course to help the patient to become well. But in every case in which the prognosis did not exclude it, "to become well" included and implied a sufficient degree of recovery to resume full flying duties. This was an inescapable aspect of the medical officers' duties, although positive exhortation along these lines was better left to the executive.

If a return to flying had formed no part of the aim of treatment, the simplest and perhaps most generally successful measure would have been to advise the suspension of every case displaying an anxiety reaction from the obligation of further flying duties indefinitely, leaving the patient's self-respect to decide unaided when, if ever, he should attempt to resume the duties for which he had volunteered. By removing the cause of conflict this would unquestionably have removed all symptoms in many cases, although among the most intelligent of the men, the haunting implication that even with the doctor's approval, they had ceased a little too readily from mental strife, would have survived to distress them. But in point of fact the unit medical officer had a duty to the unit as well as to the individual ; and if he had evaded this by offering each individual a solution to his difficulties at the expense of the more resilient members of the Group, he would have ended by betraying them all. He had his part to play in the maintenance of general morale ; and indifferent morale can rot the fittest body of men. There are few epidemics as formidable.

The extraordinarily high level at which morale in fact prevailed, despite the casualty rate already mentioned, may be deduced from the following figures. The incidence of breakdown among aircrew in Bomber Command over the whole period of the war did not exceed 5 per cent. The casualty rate over the same period, as given in round figures by Air Marshall Sir Arthur Harris, was 44,000 killed and 11,000 taken prisoner, out of a total flying force of 125,000. To this would have to be added the number of those wounded or injured in crashes, which he estimates at over 20,000.

The casualty rate for killed and missing therefore was in the region of 48 per cent., and for killed, missing, wounded and injured, 64 per cent.

That the majority of aircrew could not fail to be aware of the practical implications of the second figure only serves to make the first the more remarkable.

ANALYSIS OF CASE MATERIAL.

The tendency of cases with psychogenic symptoms to fall into one of four groups when analysed from the standpoint of stage of tour reached and flying stress sustained was exemplified in a striking manner by a series of 46 consecutive patients seen by the writer. See Table I.

The three groups revealed here clearly correspond to three phases of the operational tour ; the beginning, the middle, and the last four or five sorties. The reason for postulating the existence of a fourth group is apparent if prognosis is taken into account, based on a follow-up in every possible case, and correlated with the nature of the precipitating stress.

TABLE 1

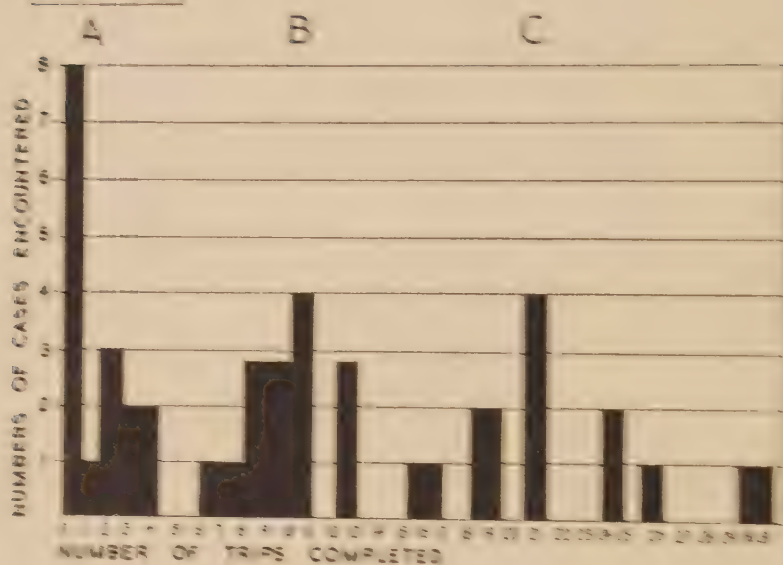
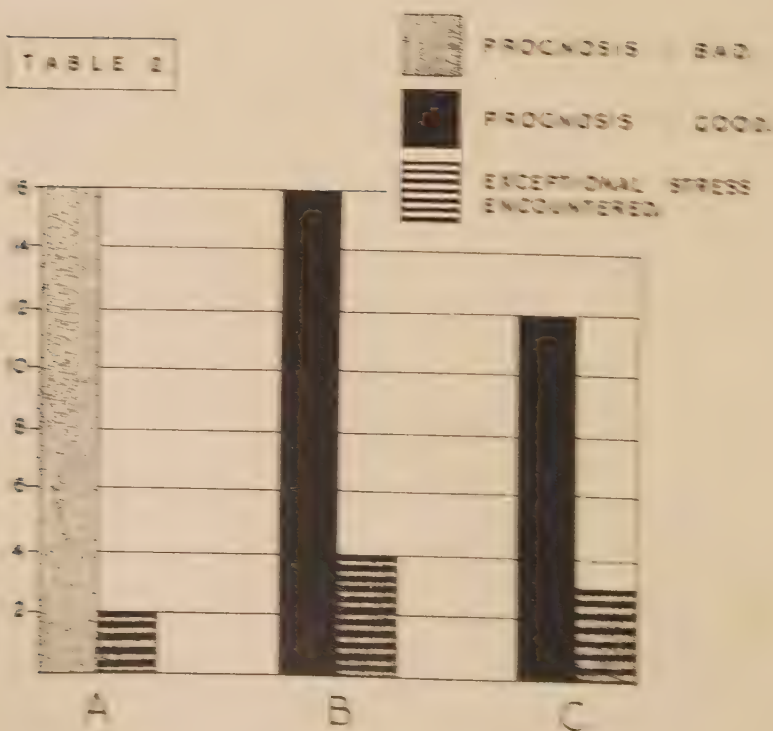


TABLE 2



In Table II the three groups are represented as three separate columns corresponding in height to the number of cases falling into each. Beside them are smaller columns representing the cases in which altogether exceptional stress was encountered. Prognosis is shown as GOOD in all cases in which return to full flying duties in the same tour or a second tour was known to have been achieved; it is shown as BAD in cases in which removal from further flying duties ultimately became necessary on medical or executive grounds, or in which considerable doubt was felt as to eventual recovery for such duties.

It will be seen that of 16 cases in Group A, all carried a bad prognosis, but only 2 had been subjected to exceptional stress; whereas in Group B, all carried a good prognosis except those 4 whose stress was unusually severe. In each one of these 4 cases (Nos. 38, 39, 40 and 41 in the appendix of case histories) it is worth noting that the severe stress had culminated in a single appalling experience. Similarly, in Group C the only 3 cases whose prognosis is noted to have been bad are the three who had suffered an overwhelmingly terrifying ordeal (Cases 34, 35 and 36).

The inference from this is that incidence of psychogenic disability in aircrew displays a tendency to occur at three different stages in the operational tour, leading to the appearance of three groups of cases; those groups in turn differ in prognosis for return to full flying duties; the general outlook in the first being poor while that of the second and third is good. Cases whose breakdown has been precipitated by flying stress of exceptional severity form a group of their own whose prognosis seems not to share this relationship with the stage of tour attained. Separated, they constitute a fourth group.

By labelling these four groups A, B, C and D respectively, and proceeding with a further analysis of the series of cases, the following table is obtained.

TABLE III.

Group.	Loss of confidence.	Anxiety.	Hysteria.	Depression.	Fatigue.	Total cases.	Prognosis for further flying.
A.	5 .	3 .	5 .	1 .	— .	13 .	Generally poor (see discussion)
B.	— .	13 .	— .	1 .	— .	13 .	Good
C.	— .	4 .	— .	2 .	2 .	7 .	Good
D.	1 .	8 .	— .	— .	— .	9 .	Generally poor (see discussion)
Mixed group- ing	1 .	3 .	— .	— .	— .	4 .	
Total	7 .	31 .	5 .	4 .	2 .		
Percentage distribution (neuroses only)		79.4 .	12.8 .	10.4 .	5.2 .	{ Total cases . 46 Medical . 39 Non-medical 7 Total reactions 42	

The percentage distribution of neuroses is calculated after subtracting the 7 non-medical cases: leaving a total of 39 cases which displayed 42 types of reaction.

This is a table showing the incidence of the various types of reaction in each group; the diagnosis of "Loss of Confidence"; "non-medical" is a

Service term reserved for cases whose reaction to stress is characterized by a collapse of morale rather than by conflict leading to true psychogenic illness. The heading of mixed grouping covered four cases whose history and general characteristics qualified them for inclusion in one of the first three groups, but who had also experienced particular stress adversely affecting their prognosis.

In this and subsequent tables it will be noted that the total number of reactions encountered exceeds the total number of cases ; this is because some cases displayed elements of more than one reaction.

Table IV is an analysis of the percentage distribution of all reactions in this series. It is of value in indicating that the series, although necessarily limited in number, provided a fair cross section of the common types of case to be encountered in work of this nature. An analysis of 1197 cases of neurosis or loss of confidence in aircrew by Symonds and Williams (10) (F.P.R.C. 412 (g)), has given very similar figures. These are reproduced for comparison in Table V.

The 39 "other reactions" in this table include such comparative rarities among aircrew as schizophrenia and organic reactions. None of these were encountered in the author's series.

TABLE IV.

Total cases = 46.

		Percentage of <i>all cases.</i>	Percentage of <i>medical cases.</i>
Anxiety	31	67.3	79.4
Hysteria	5	11.1	12.8
Depression . . .	4	8.6	10.4
Fatigue	2	4.3	5.2
Loss of confidence (non-medical)	7	15.2	—
Total of all reactions	49		

TABLE V. (Symonds & Williams F.P.R.C. Report).

Total cases = 1197.

		Percentage of <i>all cases.</i>	Percentage of <i>medical cases.</i>
Anxiety	789	65.8	77.2
Hysteria	117	9.7	11.5
Depression . . .	107	8.1	10.7
Fatigue	59	4.9	5.8
Loss of confidence (non-medical)	176	14.7	—
Other (psychoses, etc.)	39	N/A	N/A
Total of all reactions.	1287		

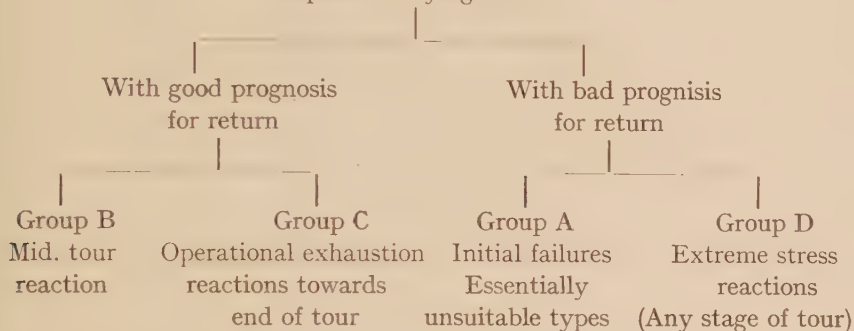
DEDUCTIONS.

From the results of the investigation just described four main groups of cases emerged ; this accorded with the general experience of the author and led to the conception of a classification based upon the type of reaction encountered, together with the accompanying history, environmental stress and stage of tour reached.

This may be diagrammatically represented below :

TABLE VI.

Men showing an unfavourable
response to flying stress



The groups are designated by letters in the order in which they are likely to be encountered during a tour of operations ; this, too, by a coincidence which is not difficult to understand, is directly although not rigidly related to the respective frequency with which they are seen. In subsequent consideration the group under discussion will be referred to by its letter as above.

GROUP A.

These are the men who break down or decide to give up operational flying before beginning operations or during the early stages of their first tour, typically within the first six sorties, without having been subjected to exceptional stress. They are drawn largely from that small section of aircrew already described whose attitude to flying and its risks was never related to reality. Many of them are perfectly well aware of the implications of their failure, and have made up their minds to try no more before being sent to see the doctor. A frank admission of inability to carry on, without constitutional symptoms, marked remorse, or distress, is common in such cases. The absence of any deep or sincere regret may be very striking. But cases do occur when the picture is one of temperamental unsuitability hitherto concealed, with diffidence, shame and mortification.

If neurotic traits are displayed they are likely to consist of a type of shallow subterfuge which strikes the observer as lying very close to consciousness. For example, men may protest that they are not so much concerned about themselves as about the rest of the crew : " I'd be ready to carry on except

that it wouldn't be fair to the rest of the crew . . ." is a remark which, in experienced ears, can almost be said to sound the knell of a patient's prospects of recovering the confidence or determination necessary to resume flying.

Other cases falling into Group A may display symptoms which suggest a mildly hysterical basis, while others still may have had their misgivings and resolution so delicately balanced that a single word from a wife or parents may tip the scales and determine them finally to refuse to continue.

As a typical example the following case may be described.

CASE 6.—A sergeant flight engineer, single, who complained of abdominal pain and throbbing headache at an altitude of 20,000 feet. He was aged 21, and had completed seven operational sorties. He gave a history of a crash in a training aircraft a year before, in which he had fractured his left external malleolus. Six months later, having resumed flying, he was involved in another crash in which neither he nor any other member of the crew was injured. Three months later, on his seventh operational sortie, his aircraft was forced to come down in the North Sea, the captain and rear gunner were killed, and the remainder of the crew spent 14 hours in a dinghy before being rescued. After this the crew were reformed with a new captain and rear gunner, but the patient had not felt fit to return to flying since his rescue from the sea. His present complaint had been troubling him for about six weeks he said.

Neither his personal history nor his family history included any neurotic traits, nor did he himself display any evidence of anxiety or nervous tension; he affirmed quite simply that he had this pain between 15,000 and 20,000 feet, that he did not know what caused it but that he did not consider he was fit for further flying under the circumstances. He had recently returned from leave during which he had been urged by his family to give up aircrew duties.

On physical examination no abnormality of any kind was discovered, and so the medical officer took the opportunity of accompanying him on a long cross-country flight, during which the aircraft flew at altitudes varying between 10,000-20,000 feet. It was arranged that an additional member of the crew should fly to perform this patient's duties so that it would not be necessary for him to know by the instruments at what height the aircraft was flying. The flight was made at night and during it the patient displayed no objective signs of distress, although he complained from time to time of vague abdominal pain and discomfort which was not in fact confined to the heights he had specified, nor referable in any way to the normal fluctuations in barometric pressure encountered during a flight at varying altitudes.

Owing to his delay in resuming flying he had been supplanted in his crew, whereupon he said that he did not consider he should fly with a new crew after what he had gone through. His general attitude suggested very strongly that he was unwilling to try further but his reasons for ceasing to fly were not considered to be medical. In deciding his disposal, due consideration was given by the executive to the stress to which he had been submitted, but the prognosis for further flying was considered to be very bad.

Other cases displaying similar traits are quoted in full in the Appendix of case histories to this group; not infrequently a previous organic or traumatic disability supplies the focus for complaint, and the hysterical element becomes evident only after full clinical examination has revealed complete physical recovery or an unwillingness to co-operate in treatment directed to that end.

One man insisted that an old meniscectomy scar completely incapacitated him for flying, but refused to perform remedial exercises (Case 9); another blamed an empyema treated successfully several years before for pain experienced only in the air in the last stages of pre-operational training (Case 11); a third, although troubled by visual disturbance, would not wear the corrected

lenses provided for him (Case 13). In such cases insight is not very difficult to provide, but it is apt to be most unwelcome when provided.

In all these cases a full and sympathetic attention to history and physical examination is clearly necessary; diagnosis must be made with particular care to determine the correct and fair disposal; but almost all of them are ultimately an executive and not a medical problem. In the author's opinion there can be no doubt whatever about the prognosis. Group A cases are absolutely useless from an operational standpoint. Their breakdown is final because their morale is intrinsically poor. Any attempts at encouragement, exhortation, or therapy to induce them to return to duty are just so much waste of time; moreover they are contra-indicated because, as has already been stressed, it is no part of the medical officer's job to indict a man whose reason for ceasing to fly is not medical. These men are essentially unwilling to fly. They have no wish to persist, no desire for any solution of their problem which will involve their return to operational duty.

There can be no compromise about their disposal; it must be immediate and decisive, and the first step is their prompt removal from the operational unit. But this, as has been stated, is the responsibility of the Executive.

GROUP B.

Men who have reached their eighth or ninth operational sortie may begin to display symptoms of anxiety or to experience a sense of deep misgiving about their capacity to continue, which brings them under the care of their medical officer. This is a characteristic and recognizable reaction, which may be expected to occur at some point between the eighth and fourteenth sorties. Despite a tendency to spontaneous recovery, immensely facilitated by treatment, morale during this critical phase may only barely maintain the level below which continued operational flying becomes impossible.

But in contrast to cases in Group A the attitude of the men in this group is one of deep distress that their resolve seems to be failing them; their underlying response is positive and courageous. They desire above all not to accept defeat, but to overcome a reluctance which they do not always recognize as natural.

They are usually frank about this reluctance and sincerely troubled by it. The symptoms are typically those of an anxiety reaction. Insomnia, battle dreams or dreams of crashes or terrifying falls, tremors, sweating, loss of weight, anorexia, tachycardia and palpitations may all be encountered. In many cases, however, the conflict is entirely present in consciousness, and the emotional reaction is tinged with despair at what the patient may mistakenly regard as his exceptional infirmity of purpose or faint-heartedness. A young pilot, whose flying record was remarkable for persistence in the face of exceptional danger, accused himself of cowardice because after twelve hazardous operational sorties he detected in himself symptoms of acute anxiety and apprehension. He was convinced he was heading for disgrace and would deserve it; but in fact he ultimately completed an outstanding tour and gained the D.F.C. (Case 22).

Again, family ties may be worrying him. Such situations are tragically hard for a man whose love and sense of personal obligation to his wife and children conflict so mercilessly with Service duty.

CASE 19.—A sergeant pilot, married, aged 24. This man consulted me after his eighth trip when he had just become a fully-fledged captain of aircraft. He said that he was afraid that his nerve was beginning to go, and that he would not be able to complete his tour of operations. In the course of conversation it was discovered that he had an additional worry, quite apart from the stage he had reached in his operational career, because his wife was pregnant and post-mature. This worried him considerably and he was waiting from day to day for news of her progress. The trips he had already completed had included several particularly unpleasant experiences, attacking well-defended targets in industrial Germany where the strength of the opposition was notorious.

His history suggested no inherent instability and, apart from a mild tachycardia and increased tendon reflexes, he showed no physical abnormality. His weight had remained steady but his appetite was poor.

Treatment consisted of a full discussion of all his problems with the suggestion that he was nearly over the worst of his troubles; and this in fact proved to be true. He was given three days' rest from flying at night, together with further encouragement and a simple tonic. He then undertook his ninth operational trip, from which he returned feeling considerably relieved and belief in his ability to regain confidence and resolution on the station. Once this definite advance had been gained arrangements were made with his Squadron Commander for him to have a few days' leave to visit his wife; during this leave her baby was safely delivered and he subsequently returned to resume and complete his tour without further trouble.

Tragedy will inevitably attend some cases where therapeutic success has been achieved; in war this must be realized and accepted. It is better that the memory of such cases should remain with a medical officer for the rest of his life than that he should discount or forget them.

CASE 21, a sergeant wireless operator, aged 28, was one. This patient reported sick on the day following a most alarming crash when his aircraft was actually taking off, from which he and the rest of the crew had managed to escape, but which had been followed immediately by fire in the aircraft, with subsequent explosion of the full bomb and petrol load. The patient had been detained in sick quarters overnight and had received 3 gr. of nembutal, which had procured him eight hours' sleep: his condition on admission had been one of restless and almost hilarious excitement which is frequently seen in men whose immediate relief at escape from a terrifying situation has not yet been overshadowed by a full and sober realization of the narrowness of the margin by which that escape has been achieved. Realization had, however, followed with the morning; this man said frankly that he wanted to give up flying: he had done eight trips and under the circumstances that was enough for him. He also said that his wife was pregnant, and he felt that he owed it to her to take no further unnecessary risks.

He was given a few days rest from all flying and in the course of several conversations the question of whether continuance with the duties for which he had volunteered could in fact be justly considered an unnecessary risk was discussed with him. The medical officer's task in this case was to help him to reach a decision in whose rightness he could honestly believe, so that the conflict by which he was troubled could be solved without the development of further symptoms. The outcome of these consultations was his decision to resume flying: this was obviously a very difficult decision for him to make, but having made it he seemed relieved at having overcome his irresolution for better or worse. He did not falter in his purpose, but he was killed in a collision in the air on his tenth trip when his aircraft was returning from operations.

The general tendency in these cases is to recover morale and confidence sufficiently to continue full duty and, if they survive the hazards which it

involves, to complete their tour. The medical officer's obligation towards them is to assist them in regaining their self-respect and in recovering their original attitude of resolute courage. That is what they seek when they come to him, and in the great majority of cases it is in his power to help them to achieve it. Once through this unhappy period they are unlikely to falter again, although a small proportion of them may recur in Group C, suggesting a less hopeful prognosis for a second tour after their rest. Many of them, however, recover completely, resuming flying out of the resources of their own courage ; and they do not look back.

GROUP C.

Cases in this group are precipitated by emotional fatigue linked usually to anxiety due to the cumulative stress of continued operational flying. They are seen typically in men who have successfully completed a fair number of operations ; usually more than two-thirds of their tour. Such patients commonly exhibit tachycardia, insomnia, chronic lassitude, depression and anorexia, with often marked loss of weight.

Symonds and Williams (10), of the Aircrew Research Detachment at Oxford have visited many operational stations in the Royal Air Force, including that under the medical charge of the author, to study the early signs of this condition at first hand, and to discuss them with experienced medical and executive officers. In a subsequent report on the results of their investigation they quote the comment of one squadron commander of proven soundness and reliability, who remarked that while no hard and fast rule for the characteristic behaviour of such patients could be laid down, they were apt to exhibit a reversal of their usual habits ; the noisy, exuberant extraverted type of fellow became silent, morose and solitary, while the naturally shy or secretive individual assumed a false jocularly, often accompanied by unwonted alcoholic indulgence and talkativeness. But in both cases the pathological nature of the reaction is evident ; there is frequently a paranoid or depressive element in the reaction of solitude, a desperation underlying the gaiety. Drinking too much and too often is sometimes a significant indication of a man's sense of subjective fatigue. Emotional lability, leading to sudden quarrels or unexpected tears, may also be observed. A man who had successfully completed an operational tour burst into tears when he realized that his medical officer was sincerely concerned to help him over a subsequent dread of even non-operational flying ; kindness had released an emotional outburst which the anticipation of hostility had until then held in check (see Case 31). Another extremely conscientious individual with an innate and very severe fear of any form of flying wept openly when attempting to discuss his difficulties (see Case 33).

A wise commanding officer can often detect these cases as early as their medical officer. They occur typically among a good element in the aircrew who tend to drive themselves unmercifully and who are often of a mildly obsessive frame of mind. They may have become fatigued because the cumulative strain of operations in their case has been excessive, because their

imagination and sensitivity are unusually highly developed, or because their resistance, although adequate, is not extreme.

Such men deserve and require immediate rest from further operational flying ; decision on the part of the medical officer, coupled with the co-operation of the squadron commander, can always achieve this. Lord Moran (II) records that he has learnt from commanding officers in the R.A.F. that the changes just described suggest a poor prognosis for eventual return to full flying. "They taught me that when a pilot's behaviour on the ground changes, when a lad who had been the life and soul of the mess becomes silent and morose, when he loses interest and zest, and becomes critical and bad tempered, then it is too late to save him."

This generalization is true only of the current tour. Correct treatment involves its ending. But provided these men are caught in time, before continuing and increasing exhaustion causes them to break down or to make a fatal mistake in the air, as, if they are missed, it almost inevitably will, prognosis for a second operational tour, after adequate rest and change, is good.

GROUP D.

In this group are included all men whose breakdown had been precipitated by an exceptional strain, often imposed by a single appalling experience which has utterly horrified and distressed them. The precise nature of the exceptional strain will of course vary in each case, but its severity is the criterion for the inclusion of any particular case under this heading.

These cases include some of the most exacting with which the medical officer has to deal. Assessment, diagnosis, prognosis and management are all frequently complicated and difficult ; breakdown may occur at any stage in the tour, and it must be remembered that an exceptional strain may precipitate collapse of morale in any of the types described in the previous three groups, as well as in otherwise resilient aircrew.

Previous knowledge of the man, and full understanding of the nature of the strain are unquestionably essential ; as always, but above all in these cases, sympathy and imagination are indispensable to a wise and fair decision. Whether or not the case is considered to be purely medical, allowance must be made for the effect of the strain on the man's demeanour in assessing disposal or prognosis.

A man who still has it in him to complete a tour will usually show marked improvement within 48 hours of the development of the acute emotional reaction which is almost invariably seen in these cases. This reaction may take the form of a hectic exhilaration amounting to hypomania, or it may be characterized by extreme pallor, physical and mental exhaustion, and shock, succeeded after a few hours by utter dejection and weary, tremulous depression.

But persistent symptoms of depression or anxiety state, or a frank inability to face any kind of flying after three days, suggest a bad prognosis for resumption of the tour. Prognosis for a second tour scarcely comes into the picture at this stage, but it will depend ultimately upon the man himself more than upon the severity of the experience which has temporarily overwhelmed him.

A particularly vivid example of such an experience is provided by CASE 40. This N.C.O., a flight sergeant rear gunner, displayed an acute anxiety reaction produced by severe flying stress. He was rear gunner in a crew who had completed twelve sorties, on the fourth of which, returning from Berlin, they crashed into the sea and spent twelve hours in the dinghy before being rescued by the Air Sea Rescue Service. They continued to operate after this and on every one of five successive trips were attacked by night fighters; this was at a time when enemy opposition had reached its most energetic stage. For persistent and devoted duty over this period, the captain received the Distinguished Flying Cross. On their twelfth trip a night fighter destroyed their starboard outer engine over Germany; the aircraft began to spin and the starboard inner engine failed. With both port engines over driving in the spin the aircraft was crashing out of control and the captain ordered the crew to abandon aircraft. Owing to the force of "G" (the centrifugal force developed by the powered spinning dive which the aircraft was undergoing), this rear gunner found that he could not open his turret doors to reach his parachute and, after struggling furiously for several minutes, and seeing the parachutes of two others of the crew open far below him, he attempted to resign himself to certain death, trapped in the turret of an abandoned and crashing aircraft. When describing this he remembered covering his eyes and weeping, and then feeling there must be something he could do, and renewing his attempts to force his way out of the turret. After several minutes the aircraft gradually resumed level flight and he was able to escape from his turret into the rear of the fuselage, where he saw two other members of the crew. They, and the captain, had remained with the aircraft because another member of the crew's parachute had fallen out, leaving him unable to abandon the aircraft. By this time the aircraft had lost about 13,000 feet of height, but by a miracle the captain had it under control again. They returned to base across Germany on two engines and below 10,000 feet, until after half an hour the inner starboard engine started up again. On his return this N.C.O. and the rest of the crew were admitted to the sick quarters for the night and given the routine treatment for emotional shock, and by the following day they were fit for discharge. The patient stated frankly that he felt quite unable to face entering an aircraft again for the time being, and he was permitted to proceed on leave without doing so. He was an Australian and had no real home in this country, but spent most of his leave visiting relatives of the men who had baled out over Germany.

On his return he reported sick, complaining of acute depression, exhaustion and anxiety. There was no evidence of pre-disposition on previous history, and apart from his pallor and loss of several pounds of weight, his physical condition was not abnormal.

Immediate treatment by the medical officer on the station is of the utmost importance in these cases. Continuous unobtrusive supervision and the provision of sound sleep play a large part in the medical officer's management of a man whose immediate response to treatment on the station has been favourable. There is of course a tendency to substantial and rapid recovery in all these cases, who are usually young and emotionally resilient; but it must be remembered that they are also naturally impressionable, and the prospect of resuming flying once this has gained a terrifying association in their minds may itself prolong symptoms of the emotional reaction.

In cases where this occurs, treatment away from the unit offers the only reasonable hope of complete cure, quite apart from any question of an ultimate return to flying, which must take second place in the mind of the physician.

These men are ill; they are psychiatric casualties; and if what they have suffered has proved too much for them to bear, premature attempts to encourage or persuade them to resume full flying duties are as misplaced in their case as they would be in cases falling under the Group C classification.

DISCUSSION.

As can be seen from the description of the four groups and a study of the appended case histories, certain conditions are more likely than others to be encountered in a particular group.

Group A cases usually include *all* men whose basic attitude to flying is unsatisfactory, whose motives for volunteering were inadequate or ill-considered, or whose morale, courage or confidence are below the minimal requirements for successful aircrew. Practically all men severely predisposed to the development of neurosis can be expected to break down in this way; but a small number may last into Group B or C, and some complete a tour despite the immense handicap imposed by their neurotic tendencies (Symonds) (8, 10). Of the frank or early neurosis seen in Group A, anxiety states predominate, although the few cases of hysteria seen in aircrew are largely confined to this group. Fatigue syndrome or obsessive compulsive reactions are most uncommon under this heading.

On the basis of completed sorties, the line dividing Group A from Group B cannot be rigidly drawn, but it is valuable as a general indication. Cases have been reported where men whose attitude to flying, response to encouragement, and subsequent performance justified their inclusion in Group B, came to the medical officer after their third or fourth sortie. This is uncommon. Men whose desire to continue is sufficiently positive do not usually experience serious difficulties as soon as this.

Group B cases include most of the mildly obsessional types of personality encountered among aircrew; as has been stressed, they are typically very keen to continue if they can, and to a certain extent their obsessive trend can be utilized to help them to do so. Emotional reactions characteristic of anxiety, and to a lesser extent true early or mild anxiety states are also to be expected; hysterical symptoms, if seen are usually very amenable to explanation and vanish readily; however, they are uncommon in this group, and where they occur predisposition is likely to be severe and the case a borderline example between Groups A and B.

The typical case seen in Group C might be expected to be the fatigue syndrome; but by definition this syndrome excludes anxiety or depression, being characterized by apathy and indifference. Such cases are a small minority in Group C. Those commonly encountered are anxiety states or depressions in which prolonged stress has led to an emotional and often subjective exhaustion. They were originally called fatigue cases with anxiety, or anxious depression, by the author, but this led to confusion with fatigue syndrome and has been abandoned. Anxiety is so frequently a significant factor that it is certainly true to say that of all reactions to the stresses of flying, anxiety is by far the most common. This is eminently understandable; there can be remarkably few people who have flown without experiencing some feelings of anxiety; none, except the constitutionally fearless discussed by Symonds in his Croonian Lecture (8) could fail to experience them on an operational flight during the period of the author's observation. A mixture

of fatigue, cumulative anxiety, and an obsessive personality is another type of case to be expected in Group C.

Following the extreme stress which is the criterion for Group D cases the immediate reaction is most commonly emotional shock ; this may be followed either by recovery or by an anxiety state, profound depression or hysteria. Hysteria is, however, as rare in this group as its general uncommonness among aircrew as a whole would suggest. Gillespie has commented on this rarity and has advanced an explanation for it, linking it with the natural self-respect of the aircrew type, and with the pride fostered by technical accomplishment and difficult achievement.

APPLICATION OF THE GRAPH.

Re-examination of the graph (Fig. 1) illustrating the fluctuations in the morale of normal men fulfilling the duties of aircrew provides a possible explanation of the apparently arbitrary appearance of the four groups of cases revealed by the investigation and just described.

This conception when applied to each of the four groups in turn, will be found to correspond to a significant extent to the type of reaction, prognosis and indication for treatment already outlined.

This suggests that it is in fact valid. In every case seen by the writer, the relevant phase of the graph, as well as the particular reaction encountered, was of very great importance in designing treatment and assessing prognosis.

GROUP A.

The significant characteristic of these cases, whether they displayed anxiety reactions, hysteria, or frank reluctance to persist with operational duties, was their comparatively poor morale. They started with this disadvantage and it rapidly led to their undoing as aircrew. Faced with the realization of acute danger their morale follows the downward trend, but because its initial level and quality are low, their departure from their more resilient fellows is illustrated by the characteristically steep descent of their curve and its failure to rally before the critical level has been reached (see Fig. 2).

GROUP B.

The original graph (Fig. 1) showed the tendency of all flying men to go through a phase of lowered confidence between about their eighth and fourteenth trips. When this is accentuated either by temperamental or environmental factors, of which family responsibilities provide a very understandable example, this difficult period may constitute a critical phase as shown in Fig. 3. Provided men can be helped through this phase the resurgent trend in morale will follow the general curve outlined at this stage in Fig. 1 and reproduced in Fig. 3. It is this conception that must underlie the efforts of the medical officer to help men whose cases fall into this group ; it is on this basis that he can honestly reassure them not only that the reaction is itself perfectly natural, but also that if they can hold on for a time, their confidence will recover.

The difficulties presented by cases on the border-line between Groups A and B have already been considered.

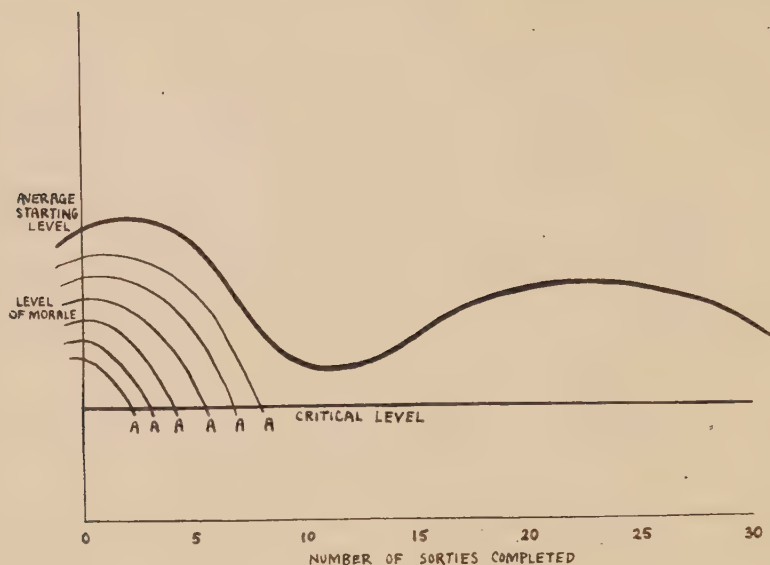


FIG. 2.

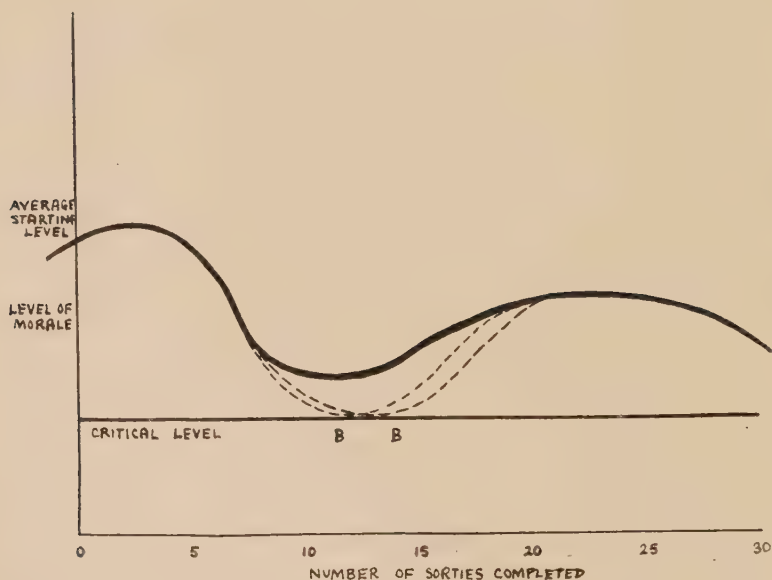


FIG. 3.

GROUP C.

In discussing the original graph the effect of cumulative stress and resulting fatigue, both emotional and physical, was mentioned as particularly significant from about the twenty-fifth trip onwards.

When this affects confidence in the manner shown in Fig. 4, cases will occur in Group C of anxiety or depression. True fatigue states, by definition "cases in which the outstanding complaint is of undue fatigability of mind and body

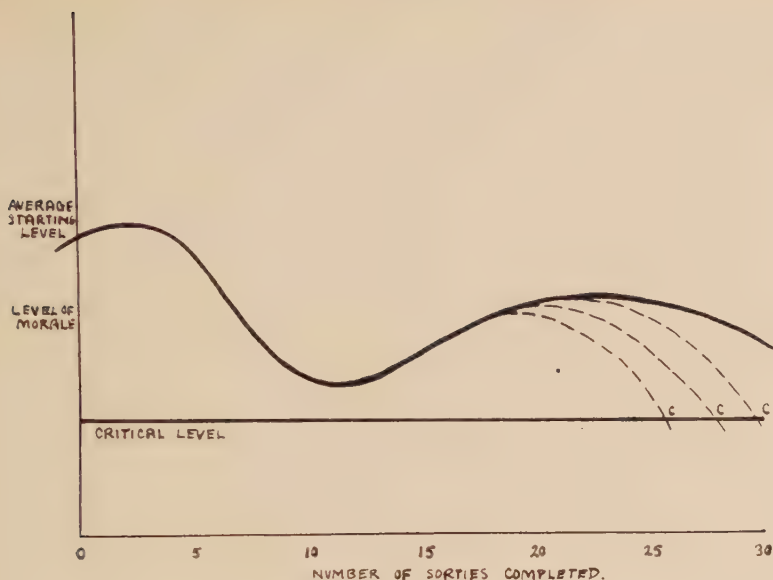


FIG. 4.

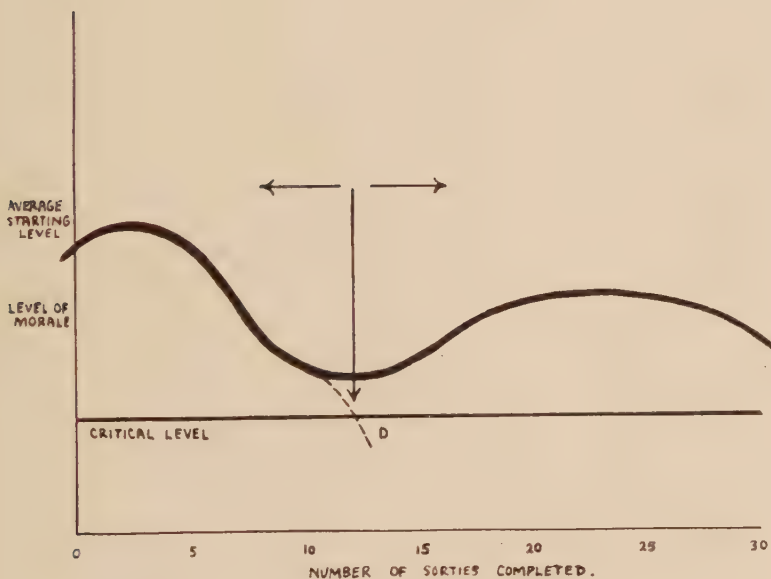


FIG. 5.

without adequate background of anxiety, depression, or obsessive compulsive reaction" (Symonds (10, 12)), are far less frequent in this group.

GROUP D.

Fig. 5 is simply a diagrammatic illustration on the basis of the graph of the tendency of an exceptional strain to precipitate collapse of morale in any of the types described in the previous three groups, as well as in otherwise

resilient aircrew. The exceptional strain is represented as a line of force driving down morale at the particular point at which it happens to operate. This, of course, may occur in training or at any stage of the operational tour.

In every one of these four figures corresponding to the four groups the curve of the original graph has been retained to illustrate the correlation existing between the groups, deduced empirically from observation of cases, and the conception of the fluctuations in morale by which they may be explained.

Such then were the effects of the stresses of operational flying in Bomber Command upon the men who encountered them ; stresses to which the majority proved themselves more than equal.

It has been the aim of this paper to illuminate an aspect of flying stress and the response it evoked from normal men ; this has in turn involved examining some of the manifestations of human courage. From whatever aspect it is examined, to whatever analysis it is submitted, courage emerges and remains an element which transcends the limitations of purely scientific observation. But it will always be a proper study.

SUMMARY.

This paper records an investigation into the morale, reactions to the stresses of flying, and incidence of neurosis in members of operational bomber aircrew. It is based on observations made over a period of four years by the author while a medical officer to a heavy conversion unit, and to four bomber squadrons. This involved responsibility for the medical care and supervision of over 4000 members of operation aircrew.

From the results of this investigation two main sets of deductions are drawn, leading to two inter-related conceptions ; one, a tendency for the majority of cases of neurosis or breakdown to occur at one of three stages during the operational tour, the other an appreciation of the fluctuations to which morale in normal aircrew is subjected by the stress of operational flying. This second conception is expressed in the form of a graph and provides a theoretical basis for the first whose empirical evolution has been described.

An account is given of the application of these related conceptions to the assessment of correct treatment, prognosis and disposal of men displaying an excessive reaction to the stresses of operational flying or training. Fear is accepted as the underlying factor in this reaction, whatever its outward form. This is a perfectly natural and almost universal emotion, but it is balanced by courage, confidence and resolution ; these make up morale.

The graph has been drawn to illustrate successive fluctuations in the morale of normal men during the course of an operational tour, starting from the final phases of training.

Although these fluctuations occurred to a varying extent in practically all normal men flying as aircrew in Bomber Command, in less than 5 per cent did they lead to breakdown, despite the intensity of the stresses involved.

I should like to acknowledge with gratitude the interest and constructive criticism of Sir Charles Symonds, C.B., K.B.E., D.M., F.R.C.P., and Dr.

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APPENDIX OF CASE HISTORIES: HISTORIES OF THOSE CASES
SPECIFICALLY REFERRED TO IN THE TEXT.

CASE 9.—A sergeant rear-gunner, single, aged 21. This N.C.O. injured his left knee playing football while in the final stages of his training, and required a bilateral meniscectomy of the left knee joint. Clinical recovery appeared normal, but he failed to make satisfactory progress in rehabilitation and after some months the orthopaedic surgeon in charge of his case finally gave his opinion that no further orthopaedic treatment was indicated; he recommended that the patient be referred to a psychiatrist.

Seen on the station the patient displayed an ominously hysterical attitude towards his disability, which he stated categorically made further flying quite impossible, while it remained in its present condition. He maintained that he was unable either to enter or leave the rear turret of an aircraft owing to the limitation of flexion in his knee, and that he was "fed up with exercises and being messed about generally." It was pointed out that the object of the exercises was to enable him to recover full use of his knee, and that if he no longer wished to achieve this and was unwilling to attempt it, it was unreasonable for him to blame the accident for his continued absence from flying. His reply to this was that no one could make him fly if he was not fit to do so, and shortly afterwards he informed the squadron commander that he was finished with flying for good.

CASE 10.—An acting-sergeant air gunner, married, aged 27. This sergeant had completed a total of 40 flying hours with one operational sortie lasting 5½ hours. He had been involved in a minor crash in which no one was hurt, and a few days later he came complaining of vague dizziness and feelings of strangeness which he dated from the crash. This proved purely a conversational opening and in the course of the consultation he showed complete insight, saying—"I'm sorry, but I just don't want to fly any more. I want to go back to a ground job. I can't face any more operations." He responded to questions as to why his attitude should have altered so completely at the very outset of his operational career after one crash landing which had scarcely affected the rest of his crew by saying that he was married, felt he had his wife to consider, and had lost his three best friends in the unit when they had failed to return from a recent raid.

Both his family history and his personal history showed evidence of considerable pre-disposition to neurosis: he had three brothers, two of whom had had nervous breakdowns following trivial accidents, in one case necessitating treatment in hospital. His own motives for becoming an air gunner were difficult to discover; he seemed to have given very little thought to the matter before reaching his present situation.

His present condition was one of normal physical and mental health. Having made his pronouncement that he wanted to do no more flying he was no longer in the least disturbed and viewed the prospect of losing his rank and flying badge with complete equanimity. "A ground job is good enough for me" was his comment and summed up exactly his mental attitude. He was not a medical case and his disposal rested with the executive.

CASE 11.—A sergeant mid-upper gunner, aged 20, married. When just about to commence operations on four-engined heavy bombers, with 78 flying hours, but no operational experience whatsoever, this N.C.O. complained of pain in his back over the site of an old empyema scar. This pain was associated solely with flying; he never experienced it on the ground. From the outset this seemed likely to prove a functional manifestation, but after a careful clinical examination of his chest had revealed no abnormality he was X-rayed and the second opinion of a physician was obtained. The effect of this was to exclude the possibility of his pain having an organic basis and the psychogenic nature of the symptom was

then explained to him, and he was invited to consider whether he had any particular misgivings about commencing operational flying, which he had not so far revealed. He then said that the trouble was that his wife was very much against him flying and he felt he ought to give it up for her sake. He was by now quite prepared to believe the pain of which he had complained did not in itself constitute a reason why he should not be passed fit to fly but he maintained that he had really no enthusiasm for flying at all and was rather sorry he had ever volunteered in the first place.

Prognosis for a successful approach to operational flying was clearly quite hopeless and the squadron commander was advised that the disposal of this case must rest with him.

CASE 12.—A sergeant navigator, aged 21, single. This man had completed 130 flying hours, including one operational sortie lasting 6½ hours. He reported sick, complaining of continuous severe occipital frontal headaches and a feeling of intense depression. He was extremely pale and said he wondered whether there was anything the matter with his eyes.

After the completion of his first operational mission he had developed coryza which had resulted in his being taken off flying for 48 hours. The next evening his crew, carrying a substitute observer, crashed on return from a cross country flight, and six of them, including the captain and the substitute who had gone in his place, were killed. A service funeral had been held for several members of this crew, which he had attended in the role of chief mourner, an experience which had depressed him considerably. At the time of the consultation he appeared to be developing an early anxiety syndrome.

On physical examination there was no detectable abnormality and an expert ophthalmological opinion excluded an ocular basis for his headaches. In his family history there was nothing of great significance, but he told me that immediately after the crash, in which most of his crew had been killed, his father had been taken seriously ill and he received news that he might be dying; this had naturally increased his distress. His personal history suggested a moderate degree of pre-disposition: he had a nervous breakdown lasting almost 18 months with headaches and insomnia when he was nine years old. He attributed this to excessive study: he had been spending three hours every day at music practice in addition to his normal school.

In view of his undoubtedly genuine distress and the stresses which his father's illness, his friends' death and his own purely fortuitous escape from inclusion in their accident had imposed upon him, an attempt was made to give him insight into the basis of his headaches, with as much encouragement as could reasonably be offered him. He responded fairly well to this, and it was then suggested that after taking part in a second operational sortie he should go on leave to see his father, the gravity of whose illness had apparently been slightly exaggerated in the first report. He did this and was then posted to another unit to pick up a new crew; but his recovery was short-lived for after one further operation with them he developed a full-blown anxiety state and had to be made permanently unfit for further flying.

It will be observed that his was one of the less common cases in this group where a genuine temperamental unsuitability did not prevent him trying unsuccessfully to achieve a standard of war service which was, in fact, beyond him, or from suffering in the attempt.

CASE 13.—A flight-sergeant pilot, single, aged 23. This patient, a flight-sergeant with no operational experience who was completing his course as a pilot on four-engined bombers, complained of headaches and disturbed vision since a crash he had had at his operational training unit. He had escaped unhurt and had flown again the same day.

Complete medical examination revealed no abnormality except a slight error of refraction for which corrective flying goggles were prescribed by the ophthalmologist. He then complained that his goggles were unsatisfactory, but a further ophthalmic opinion a month later pronounced them perfectly correct.

He persisted in complaints that he was unable to land his aircraft with or without the goggles. Accompanied by his medical officer on a flight he made moderately good landings despite protests that the goggles were useless to him.

Subsequently he refused to wear them at all and proclaimed himself unsafe to fly; to continue would not be fair to his crew he said.

He was considered to be a case of reluctance to fly with a very slight element of hysteria. Prognosis for operational flying was hopeless. His case, with a full report, was placed in the hands of the executive for disposal.

CASE 20.—A sergeant navigator, single, aged 25. Following his tenth trip this sergeant reported sick, having suffered from nausea and vomiting while in the air, which had prevented his aircraft from making a successful attack. He had not previously suffered from airsickness at any stage in his training, and had completed over 200 hours in the air, but after his fourth trip, when his aircraft had crash landed at a coastal aerodrome after being damaged by anti-aircraft fire over the target, he had developed an increasing apprehension during flight which he was soon able to see was directly related to the development of airsickness in his case.

There was no abnormality in history or on full physical examination. He reacted very well to the explanation offered him, coupling his airsickness with his natural apprehension following his earlier hazardous experience, and although provided with Chloretone capsules he discovered on resuming flying that he had no recurrence of nausea and did not need to take them. He showed every sign of having made complete recovery, but four trips later his aircraft was involved in a collision over England at night on returning from operations in which every member of the crew was killed.

CASE 21.—This case has been fully described in the text on p. 30.

CASE 22.—A pilot-officer, captain of aircraft, aged 24. This officer consulted me privately after completing twelve highly successful operations; he said he was afraid that he lacked "guts" and that he dreaded undertaking any more operational sorties. He could not sleep on a night when operations were in prospect nor could he eat much food during the day preceding them. On return from a mission he felt physically and mentally exhausted, but when he went to bed he would lie awake tossing and turning and wondering how he was going to face the next trip. He was a shy and solitary young man, and in the course of consultation it became evident that he had very little idea of the extent to which other men in the squadron, whom he admired, had been troubled by similar anxieties.

In his personal history there was little of significance except that he was an only child and that his mother had died when he was very young. He had great admiration for his father, who was a doctor, but feared that he was likely to bring disgrace upon the family name by an abject failure as an operational pilot. He had a pulse rate of 86, sweated freely during examination and his blood pressure was 140/80.

He was reassured about the normality of his reaction and greatly encouraged to learn that he was not unique in this respect. He was also able to see the reaction of this type would be perfectly intelligible to his father as a medical man, and was told that few people were in a better position than a doctor to understand the degree of courage and determination necessary for the task which he had set himself. He was promised that if he still desired to continue flying he could confidently expect a resurgence of his confidence and with it a very much happier state of mind about his job. He also saw readily that for him to give up flying at this stage would be the one certain way in which he would let down his crew and betray his self-respect.

He was given a simple tonic, allowed to resume flying at once, and seen nightly after his next two operations, when nembital gr. $1\frac{1}{2}$ was prescribed. After this he improved steadily and completed a full tour of operations with distinction.

CASE 23.—A sergeant rear gunner, aged 24, single. This sergeant sustained mild frostbite of his left hand following failure of his electrically heated gloves on his tenth trip, when the temperature at the altitude flown was minus 35 degrees. This disability resulted in his being taken off all flying for a week, during which time he began to become a prey to misgivings about his ability to resume flying when he should again be considered fit. He was an extremely mild case of anxiety reaction and responded perfectly to discussion and encouragement. He experienced no further trouble following resumption of his tour, and his case would probably

never have come to light had the enforced idleness due to his frostbite not provided him with an opportunity for brooding during a phase of his tour which has already been mentioned as probably the most critical through which a normal man has to pass.

CASE 31.—A sergeant wireless operator, married, aged 22. This N.C.O. had already completed a tour of operations comprising twenty-four sorties when he first came under my care. He had been posted with his crew to a station where new aircraft were delivered for allocation to operational squadrons, the duty of his crew during their rest period being to test these new machines before handing them over to operational crews. Since his arrival the patient had exhibited reluctance to fly, and had finally told the commanding officer that he was unable to face further flying for the time being. This was not easy for the commanding officer to understand, as the type of flying involved in this job was not at all strenuous or alarming; the man was accordingly told that if he wished to avoid all flying he must consult the medical officer about his reluctance. When first seen he was in a mood of truculent despair which gave place on kindly questioning to uncontrollable weeping. He said he had experienced a mounting sense of strain and tension from his twelfth trip onwards, but had told no one, hoping that he would get over it and determining at all costs to complete his tour without faltering. He now found any form of flying altogether too much for him, and supposed mistakenly that as a result he would be deprived of his rank and flying badge and lose all that he had striven so zealously to preserve and had so honourably achieved.

He was clearly in need of treatment and reassurance. After brief explanation and encouragement he was temporarily admitted to the ward, where he was given nembutal gr. 3, repeated after eight hours, thereby ensuring him a considerable quantity of sleep following his admission.

On subsequent examination both his personal and family history were good, he had been successful at school, played football for the first eleven and won several prizes. He had had no childish fears except a slight fear of the dark and of the possibility of someone following behind him in dark corridors or when ascending stairs. He had no physical disability and the nervous symptoms he had developed during his tour had been confined to mild headaches, a slight stammer, and his nervousness in the air.

He said he had liked flying up to about halfway through his tour; he had throughout placed great confidence in his captain and in the rest of the crew. Their only particularly unpleasant trip had been their last, on which they had been attacked by a fighter on the way to the target, but had pressed on and bombed it successfully. He had been married six months before, and in the course of advising about his case I had an opportunity of interviewing his wife, who was an admirable type of Scots girl. Although naturally worried about his operational flying, she had never tried to dissuade him from it, but made it clear that she would support him completely in any decision he made about further flying, whether to persist or give up. A report from the commanding officer of the squadron in which he had served stated that he was above average in the performance of his duties and had shown great keenness and enthusiasm at all times. "On actual operations he was very reliable and on no occasion had it been known for him to exhibit any form of behaviour other than that required of a sound member of aircrew during most exacting circumstances."

It was considered that his present trouble had arisen because, having completed his tour he had very reasonably permitted himself a relaxation of the effort of will which had become necessary to sustain him for further flying. The ultimate prognosis for return to full flying duties was considered to be reasonably good but an immediate recommendation for two months' ground duty, during which he would have the opportunity of flying if he so desired, was made. This case is particularly interesting in that the patient set himself to conceal his emotional reaction until in his own estimation his duty had been honourably done; and in this he had succeeded.

CASE 32.—A pilot-officer, single, aged 24, captain of aircraft. This was a similar case to the one just described. This man had also completed a full tour of operations, but had been given a ground appointment for three months following the end of his tour, and had then been posted to a station to convert senior pupil

pilots from twin-engine to four-engine aircraft. After a month's instructional duty which had involved him 26 hours' flying, he complained of feeling extremely nervous while preparing to fly or in the air, his apprehension being characterized by a continuous fear that one of the engines would cut during take-off or landing: this would, of course, be a particularly disastrous hazard when the aircraft was being flown by comparatively inexperienced pilots. The patient was a brave and conscientious man and was perfectly well aware that an instructor who was himself nervous or apprehensive had an appallingly discouraging effect upon a pupil: moreover, if he displayed this reaction by an unwillingness or inability to leave the pupil to fly the aircraft entirely by himself, however inexpertly, he would make it quite impossible for the pupil to gain any confidence on the aircraft at all.

He was in fact suffering from the cumulative fatigue of his operational tour added to a very real dread of instructing, which in a proportion of otherwise admirable pilots is very difficult to overcome. Physically and mentally he appeared perfectly well. A period of leave with mist. sod. brom. $\frac{1}{2}$ oz. *t.d.s.* was advised and the commanding officer of the unit agreed to discuss this pilot's attitude to instructing with him sympathetically on his return. This treatment proved entirely successful and the patient later became a most valuable and sound instructor. Prognosis for a successful second tour was not considered to be affected by this episode.

CASE 33.—A flying-officer, navigator, single, aged 28. This officer consulted me after completing sixteen operational sorties because he felt he could no longer continue to fly. He was on the verge of tears throughout the entire interview and broke down twice. He said that he hated flying and that he had always hated it from the first time he ever went into the air. He had discovered this at once during his initial training but had hoped that if he persisted by an effort of will he might gradually become more accustomed to being in the air: this, however, had not been his experience.

After four cross-country flights at an Advanced Flying Unit he had reported his lack of confidence to his flight commander, but following encouragement had returned to persist with flying, despite his increasing dread of it. Eventually he reached a stage at which he could only tolerate flying at all if he confined his attention to his navigation instruments and worked out the mathematical problems involved while excluding from his mind as far as possible the awareness of being airborne. This, of course, involved a tremendous effort of concentration and, even so, was by no means the whole answer to his problem, because he was expected to include astronomical and sextant observations as a check upon his other navigational methods, and the ordeal for him of leaving his navigator's compartment and climbing to the astrodome to look out of the aeroplane was almost intolerable; after doing this he felt so sick and miserable, and trembled to such an extent, that he was unable to record his findings for several minutes, thereby impairing the accuracy of this form of navigational aid to a point where it was almost worthless.

Despite this enormous handicap he was considered to be one of the best navigators in the squadron; a remarkable testimony to the determination with which he tackled his disability. At his operational training unit he had joined a crew whose morale was low and whose captain, by most unfortunate coincidence, decided to abandon flying after his first mission. His second captain flew the aircraft into the ground through what appeared to be sheer careless flying after returning from the fourth operation. The crew escaped although the aircraft was burnt out; thereafter they refused to fly under this captain. By this time the patient was dreading every landing and every take-off; only by a continuous effort of will could he compel himself to fly at all. It is pertinent to remark at this point that for any man to experience in succession two such unnerving and discouraging examples of leadership is almost incredible in the Service: the proportion of captains of aircraft who are capable of so betraying the confidence of aircrews is undoubtedly minute; and for this patient to have had so unique and disastrous an experience added to his already intense personal difficulties in supporting the stress of flying must be considered an overwhelming and unforeseeable misfortune.

Nevertheless under his present captain the patient had forced himself to complete, in all, sixteen operations, although after every one of the last four he had decided he could not undertake another; a decision which on each separate

occasion he had reversed at the last moment rather than tell the crew, who had a great regard for him, that he could not accompany them.

His mood during consultation was one of utter dejection; he could neither smile nor laugh, and he was completely miserable at his final inability to overcome his mounting dread of flying, by day or night, operational or non-operational. Physically he was perfectly normal.

His was a most exceptional case; his reaction to the awareness of height in flying (see p. 31) was pathologically exaggerated from the start, and in the opinion of his medical officer there could be no suggestion that he could be blamed in any way for this, nor that he had failed to make every possible human effort to succeed in spite of it. It was not considered that leave or any form of treatment would be of the slightest help to him as long as he was expected to continue flying. His complete lack of confidence and dread of flying had taxed his reserve of courage and determination to the utmost during his flying career, and now that reserve was completely exhausted. He was, therefore, considered to be a case for disposal under the procedure suggested for Group C patients: his sixteen trips did not constitute a full operational tour, but his persistence in the face of innate fear of flying, which had never left him, deserved and received the sympathetic appreciation of the executive.

CASE 34.—A sergeant pilot, single, aged 28. This man was the captain of a twin-engine aircraft, one of whose engines began to fail immediately after taking off for an operational sortie loaded with a four thousand pound bomb; after circling the aerodrome for some 10 to 15 minutes trying unsuccessfully to gain height so that he could reach the sea or some wide open space to jettison his bomb before landing, his aircraft caught fire in the air from a blow-back from the exhaust of the affected engine and crashed in flames on the edge of the aerodrome. The crew fought their way out of the incandescent wreckage and ran for it. Within half a minute the bomb, whose casing had mercifully been split by the heat, exploded, but with reduced blast effect. Four members of the crew were seriously injured sustaining burns and fractures; one was killed. The captain escaped with a grazed nose. He was admitted to Sick Quarters for the night and given the routine treatment for emotional shock, after which he slept fairly well. He was allowed up the following afternoon, and had a full consultation with the medical officer before leaving the Sick Quarters.

This patient had completed twenty operational trips, and was in all respects an excellent type of captain. After his immediate emotional reaction had subsided and his physical condition was perfectly normal he said quietly and finally that he could do no more operational flying. Result of examination had suggested that he could not be justly considered a purely medical case, but by co-operation with his Squadron Commander he was recommended for an instructor's course. He failed this owing to jumpiness at the controls—a sign which in pupil pilots beginning their training is considered an absolute indication for rejection unless it is very rapidly mastered. He had shown no sign of this before. The prognosis for further flying was therefore considered to be very bad, but the extreme nature of the stress to which he had been exposed was given full consideration in the medical opinion submitted on his case and secured him a sympathetic and imaginative disposal.

CASE 35.—A sergeant wireless operator single, aged 24. This N.C.O. was a member of the crew of the aircraft whose fate has been described in the previous case. In escaping from the wreckage he pulled himself up through a hatch which was red-hot at the time, sustaining severe second degree burns of the face and hands. He was treated for his shock and burns at the Sick Quarters, and transferred to an R.A.F. Burns Centre within a few hours when his condition had sufficiently improved. He made an excellent physical recovery, but after his final medical board, at which his physical fitness for return to duty had been determined, his reluctance to resume operational flying remained too great for him to master. Flying prognosis in his case was estimated to be very poor indeed; as he said himself, "his nerve had completely gone." No further encouragement or psychotherapy directed towards the restoration of confidence in flying was considered to be of any value in his case, complete psychological recovery only being possible for him when the suggestion of further flying was finally excluded.

When seen several weeks after his permanent unfitness for future operational flying had been decided he had recovered his health and appetite and was ready and able to do a good job of work on the ground.

CASE 36.—A sergeant navigator, single, aged 23, also a member of the same crew. His injuries following the catastrophe above described were severe burns of the hands and shock, for which he received similar treatment to Case 35, with an equally good physical recovery. He came from one of the Dominions and was a very great friend of the wireless operator, who was a Scot, and who always invited him on leave to stay with his family in Scotland. These two men were inseparable companions on the station, and it was not surprising under the circumstances that the attitude of this patient to return to flying exactly paralleled that of his companion. The ordeal in all these cases had been the same, and though in the author's experience flying men have sustained comparable stresses and eventually returned to duty, prognosis in this case was the same as in the two previously described. No medical objection would have been raised to a return to flying had any of these patients proved eager or willing to do so; but as they did not the opinion was expressed that their complete psychological recovery was unlikely while the problem of a return to flying still confronted them.

CASE 37.—A sergeant wireless operator, married, aged 27. On his fourth trip returning from Berlin, where the fuel tanks had been pierced by fragments of high explosive shell, the aircraft of whose crew he was a member ran short of petrol and came down in the sea. The crew took to the dinghy, where they spent fifty-seven hours before drifting ashore off the coast of the Isle of Wight. They all required several days' treatment for exposure in a neighbouring hospital, and when this patient returned to his unit he still complained of paresthesiae in his hands and feet. On examination there were no residual signs of oedema or any other physical abnormality, and the distribution of the paresthesia was of the glove and stocking variety. During discussion the patient volunteered the opinion that he would never be fit to return to operational flying; when asked whether he thought this because he did not expect to recover fully from the physical effects of exposure, he replied quite frankly that it was not that, but rather the alteration which had occurred in his attitude to his job following his ordeal in the dinghy.

Physically and mentally he displayed no sign of abnormality apart from an increase in his natural reserve, and a quiet but rather desperate insistence that he could undertake no further operational flying. He had also gained the impression that another member of the crew (Case 38) who had completed ten sorties at the time of this experience in the dinghy would be automatically removed from further flying, an impression which was not in fact correct, and he said that although he had completed less than half the other man's total of operations, he felt that the stress had been so great in both cases that they should receive similar treatment.

It was explained to him that other members of the crew were in fact anxious to attempt further flying, and that they would be encouraged to do this; he replied by asking if he could have a medical board as he still sincerely believed that he was not in fact physically fit for operational flying, quite apart from any question of his willingness. His request was promptly granted, but the prognosis for his return to flying was not considered at all good whatever might be the verdict of the medical board as to his physical fitness.

The board considered that he was physically fit for full flying duties, but concurred with the opinion of the station medical officer with regard to his attitude towards further flying and the resultant prognosis. Following a full medical report embodying these opinions and directing attention to the stress to which he had been subjected, he was permanently removed from flying duties by the executive.

CASE 38.—A sergeant navigator, single, aged 26. This man was the navigator in the aircraft referred to in the previous case. He had completed 250 hours' flying, of which 72 hours had been made up by ten long operational trips. At his medical board convened to assess his fitness for return to operational flying he was noted as displaying an anxiety reaction due to the stress of his recent experience. Under the supervision of his station medical officer he made a gradual

improvement, was sleeping well and in good general health. During this time he had been given a medical category which permitted him to engage in non-operational flying only; an assistant medical officer flew with him on cross-country flights from time to time, and reported that although he was obviously doing his best he was far from happy in the air, particularly when the aircraft was flying over sea. The prognosis in his case was considered to be doubtful, but he still displayed evidence of a desire at least to try to regain confidence, and this opinion was expressed in a report to his next medical board, with a suggestion that he would probably require a further period of rehabilitation before a definite conclusion as to his correct disposal could be reached. Following this he was posted to a non-operational unit, and unfortunately it has proved impossible to follow up this case. Despite this somewhat unsatisfactory conclusion the case has been included as an example of the essential difference introduced into prognosis by the element of desire to continue despite the exceedingly severe strain which had been imposed.

CASE 39.—A sergeant rear-gunner, single, aged 22. This N.C.O. was rear gunner in a bomber, and was hit by cannon fire from a night-fighter on his tenth sortie. He sustained a gun-shot wound of the jaw, which was fractured, and of the left hand and lower third of the left leg.

He was treated successfully at a maxillo-facial unit and made a good recovery from all his injuries. After seven months he was considered fit to resume full flying duties, but at his final board he displayed symptoms of early anxiety neurosis and admitted that he dreaded a return to flying. He was given a period of two months' ground duty, during which he was encouraged to talk over his troubles with the medical officer, but it was clear that the shock to his morale of his particularly dangerous and unpleasant injuries suddenly incurred from an enemy he never saw had permanently impaired his confidence. My opinion, recorded privately at the time, was that he was finished for operational flying. His final medical board (nine months after the injury) confirmed this, making him permanently unfit for operational flying duties.

CASE 40.—The details of this man's ordeal have already been fully described in the preliminary description of Group D cases (p. 33). He had already had a hard time after the crash into the sea, developing slight functional epiphora, but after explanation and reassurance had overcome this to persist with the rest of the crew. This in itself proved him to be a trier. After this final disaster, during which he had vividly anticipated a violent death when the aircraft crashed on to German soil, he had become utterly miserable, feeling subjectively ill, completely disinclined for food, exercise, or interests of any kind, unable to sleep, and expressing himself in conversation as "sometimes wishing it was all over."

This then was a case of breakdown after very severe stress who had tried as hard as he possibly could to do his duty. Treatment away from his unit seemed to offer the only reasonable chance of recovery of fitness for flying. He was accordingly admitted to hospital, where with some months of rest and psycho-therapy directed to the evaluation of his symptoms and the restoration of his confidence in himself he recovered his health and spirits, after the decision finally to remove him from further flying had been made. He was encouraged to resume full non-flying duty in a job which interested him, and suffered no stigma in view of the severity of the stress to which he had been subjected. Seen again eight months later he was fit and well and had regained his self-respect and happiness.

CASE 41.—A flight-sergeant navigator, single, aged 21. This flight-sergeant was a navigator of the same crew whose experiences formed the background to the description of the previous case. He was in fact the member of the crew who discovered that his parachute had fallen out of the aircraft after he had received the order to bale out, thereby involuntarily imposing upon his captain the obligation of remaining at the controls and endeavouring to save the aircraft, although this had at first threatened to be impossible. Before the captain had succeeded in regaining control the patient's own extreme terror was mingled with feelings of intense remorse that another man should have to face almost certain death because he himself was unable to save his own life when ordered. Rightly or wrongly he blamed himself for having lost his parachute through the open hatch of the aircraft while the first two members of the crew were in the act of abandoning her.

Following their return to base he developed symptoms of acute anxiety with anorexia and insomnia. He was a very conscientious man, who had tried hard throughout his flying career. He had himself completed 430 hours of flying at this time, including twelve operations which totalled 70 hours. This extraordinarily harrowing experience had caught him in the middle of the phase which has already been indicated as providing the basis of temporary breakdown in the cases described under Group B. The cumulative effect of this experience upon the emotional strain from which he was already suffering had led to production of the symptoms of which he now complained.

Remembering the tendency of cases occurring in Group B to achieve a degree of spontaneous improvement and explanation and encouragement, an attempt was made in his case to ease his mind at least of the sense of guilt to which he still clung because he had been unable to bale out when his captain so ordered. He was reminded that this had perhaps indirectly saved the life of the rear gunner, and knowing very well the story of the gunner's escape from the turret and his discovery that he was not after all alone in the aircraft the patient was able to appreciate this, although, as he remarked, the story might have had a very different ending for all of them if the skipper had not been able to regain control. The captain himself took the greatest interest in his crew, and told me that he considered his navigator a very valuable man and would do anything in his power to help him. The patient appreciated this, but said that he did not think he could possibly stand up to further operational bombing missions, although he would like to try to serve successfully in a less exacting flying job, for example, in Ferry or Coastal Command.

Transference from an operational command in the middle of an uncompleted tour is normally never advised or countenanced in the service for obvious reasons; but in this case the opinion was expressed that if the man had proved completely unable to undertake flying of any kind the extenuating circumstances would have deserved the most careful attention; and as in fact there seemed at least a possibility that he might regain confidence sufficiently to perform a flying job of considerable value, in his particular case an exception should be made:

By way of rehabilitation he resumed non-operational flying below 15,000 ft.; a guarded prognosis for his eventual return to any form of responsible flying duty was given. He left the unit to undertake training for duties in another command, but a follow-up of his case revealed that he did not succeed in resuming his place in a crew and he eventually required complete removal from flying duties.

It is of particular interest to note that the captain and the remainder of the crew continued to persist with their tour until on their twenty-fifth trip they failed to return from an attack on a tactical target in occupied Europe. The example of courage and resilience which this captain had displayed had inspired not only his own crew but the squadron as a whole. He had demonstrated what has already been discussed—that a sufficient degree of enthusiasm, determination, and singleness of purpose can restore confidence in some men after experiences which have absolutely destroyed it in others. Rejoicing which attended his entirely unexpected reappearance with others of his crew some months later, having escaped both from the crash and from the attentions of the enemy, was his final contribution to the very high morale in his squadron.

CASE 42.—A sergeant navigator, single, aged 22. On his fourth sortie following return to this country fire broke out in the aircraft necessitating its abandonment by all the crew. He baled out with the rest, but for some reason his parachute failed to open when he pulled the ripcord; he continued his free fall in space, and estimated that he fell over eight thousand feet before his effort to tear his parachute pack open with his hands succeeded and the parachute eventually opened; all this happened at night. He damaged his left ankle on landing, but did not come under my care until six months after this occurrence, when his medical board had recommended that he return to non-operational flying for rehabilitation.

In consultation he continually protested that he wanted to return to flying as soon as he was fit, but that he knew perfectly well he had not regained sufficient confidence. It appeared that his declarations of eagerness to resume full flying were most energetic at his various medical boards, with the result that physicians composing them tended continually to refer him back to a station for some months to reconsider his case after rest and non-operational flying. By seeing him on the

unit and accompanying him on a cross-country flight the impression gained was that in fact he was extremely uneasy about all flying and was making very little progress.

A few weeks after his first consultation with me he burnt himself accidentally by splashing paraffin on to a stove in a dispersal hut. This apparently was a particularly clumsy and careless accident, and at the time it seemed within the bounds of possibility that this might represent a subconscious escape from recovery of full fitness for flying. This was purely a personal conjecture and was never mentioned to anybody else. However, after recovery from the superficial burns and the grant of a period of sick leave this sergeant's case was finally reviewed by the medical board who, on this occasion, made him permanently unfit for all flying duties, a decision which in the author's opinion was inevitable.

It is perhaps of interest to remark that in the course of five years' service with the Royal Air Force this is the only case of which the author has heard in which a parachute has failed to open normally.

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ELECTRIC ANAESTHESIA AND ELECTRO-NARCOSIS.

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INTRODUCTORY.

IN the following pages the use of electricity as an anaesthetic agent for man and animals is discussed. An attempt is made to assess the existing state of knowledge, but the issue is a complex one, and there are many gaps and contradictions in the story. Attention is later given to the now familiar use of electricity for the supposedly humane destruction of animals, in particular the pig, dog and cat, and these practices examined in the light of the reliable evidence.

HISTORICAL ASPECT.

The concept of electrical anaesthesia is not in any sense new. According to Sir Leonard Hill (1935), Benjamin Franklin (1706-1790) made experiments in this direction, and was followed in the next century by Benjamin Ward Richardson (1869).

D'Arsonval (1890) noticed that currents of a frequency considered high at that date could induce a certain degree of narcosis. Hutchinson (1892) and Pampilion (1901) recorded that anaesthesia could be induced by appropriately applied I.D.C.,* obtained by the first worker by means of a ribbon vibrator, and by the second with a segmented wheel. Attention was then focussed on the issue by the classical studies of Leduc (1902) and his school. Over the next decade Robinovitch contributed considerably to the literature and subject, which seems then to have passed into almost total neglect until recent years.

TYPES OF ELECTRIC ANAESTHESIA.

The possibilities appear to be three-fold :

- (1) Local anaesthesia, by electrical interference with the passage of afferent impulses; as on the limbs.
- (2) Spinal anaesthesia : similar interference with nerve-function in the cord.
- (3) General anaesthesia : electrical interference with the receptor mechanisms in the brain. This may be either of brief duration, as produced by a single pulse of high density ; or prolonged, as produced by the sustained application of weaker currents.

* D.C. stands for direct current, I.D.C. for interrupted direct current.

In the greater part of the experimental work it would appear that (2) and (3) have been concerned together.

(1) *Local anaesthesia produced by electrical means.*

This aspect has received the least attention. Robinovitch, however, discusses it in Gwathmey's *Anaesthesia* (1914). She states: "In clinical work we have applied electrical anaesthesia for local anaesthesia in numerous cases." Her technique was to apply D.C. interrupted 100 times per second and with a duration of pulse of 1 msec.* The anode and cathode were secured over the nerve trunks, the anode being proximal. The method was first employed in 1910 at the St. Francis Hospital, Hartford, Conn., for the amputation of the great toe of one foot and the great, second and third toes of the other. 54 V. provided a current of 4 mA. She then refers to other surgical interferences, including two further amputations of the toes (where 9 mA. was used), and a resection of the leg, using here 18 mA. Anaesthesia would appear to have been complete in all instances, but tingling sensations were complained of at the higher amperages and she recommends 4 mA. as the current strength, not to exceed 6 mA. Special emphasis is laid on the bloodless condition of the fields of operation as a result of vaso-constriction, and on the surgical advantage of this.

Hertz (1933) failed completely to obtain by similar means any measure of local anaesthesia whatever, but successful regional anaesthesia is reported by Kalendaroff (see p. 55).

(2) *Spinal anaesthesia produced by electrical means.*

This has involved the application of D.C. or I.D.C. between the posterior aspect of the trunk and the neck or other anterior part. Many workers have applied the cathode to the head itself, thus including the brain in the circuit. This circumstance complicates the issue by including the cerebrum, and combined spinal and general effects are then probably concerned. At present only true spinal effects will be considered.

Ivy and Barry (1931) applied I.D.C. (100 pulses/sec., of duration 1 msec.) between the lumbar region and the back of the neck in dogs. The current employed was low (the voltage was 4 to 12 V.). They report that complete immobility resulted, without loss of consciousness. Respirations were normal or somewhat augmented, the pulse-rate was slowed. When the circuit was broken, the animals recovered immediately, and repetitions for a period of 10 minutes on 6 successive days were without deleterious effect. They conclude, however, that too much muscular rigidity was developed for practical (surgical) purposes, and ascribe this tonus to the inductive effects of their segmented wheel interruptor. In conclusion they observe: "We believe that the induction of spinal anaesthesia with appropriately interrupted direct current has considerable promise and warrants further investigation. Such an investigation awaits the perfection of an apparatus that is free of faradization effects or one that yields an oscillographic curve with a square plateau

* 1 msec. = 0.001 seconds.

and adequate voltage. It is believed that such an apparatus would not produce the rigidity seen in the majority of dogs on the application of the current to the spinal cord, and would render surgical operation feasible."

Silver (1939) applied continuous steady D.C. between the anus and the shoulder in rats, and records immobilization effects on the hind-quarters only. The fore-quarters remained normal.

Recent work from Italy (Martini, Gualtierotti and Marzorati (1942)), reports the induction of complete spinal anaesthesia in the cat, and has included a study of the physiological mechanism. These workers employed what they term "Greek" current—sine-wave current half-rectified and clipped or squared by passage through a pentode valve operated at saturation. This is the equivalent for all practical purposes of the current employed in his classical studies by Leduc, and referred to below.

Applied to the exposed spinal cord the current resulted in total spinal dysfunction, as monitored by the electro-myelogram. They believe this action to be reflex, since freezing the cord at a level caudal to the site of stimulation suppressed the effect. They claim, moreover, to have demonstrated that the reflex involves the stimulation of specific inhibitory centres for the spine, situated in the diencephalon (hypothalamus), and they claim by a technique of neuro-section to have localized these accurately. What is of even greater physiological interest is their statement that the centres are multiple, each acting bilaterally but having specific control over its segment of the cord.

(3) *Spinal plus general anaesthesia produced by electrical means.*

This heading covers the greater part of the experimental studies on electric anaesthesia. Most workers have followed the technique of Leduc, applying I.D.C. between the loins and the head.

Leduc's experiments.—Leduc (1902) and his colleagues applied initially faradic current, but tonus was the invariable consequence. He therefore assayed I.D.C., obtained by the interruption of battery current by a segmented wheel, at interruption rates up to 200 per sec. and over a wide range of voltages. He is quoted in translation by Regensburger as follows: "The animal is placed in the circuit, placing on the shaved head a cathode formed of absorbent cotton impregnated with a solution of sodium chloride, and covered with a metallic plate; a wide anode is placed on the shaved back of the animal at the posterior extremity of the body: the interrupter being in operation, the e.m.f. is rapidly increased in the circuit until generalized contractures are produced, the animal falls on its side, the respiration stops; the indicator hand of the commutator is then brought backward until the respiration is re-established; at a certain degree of current, a tranquil and regular sleep is obtained, the respiration continues without modification, the heart functions normally, but all of the cerebral functions are suppressed; the animal, dog or rabbit, free, without fetters, remains lying motionless in a profound sleep, the muscles are relaxed; the animal, if one raises it by a fold of the skin, is flabby and completely inert; if it is pinched, pricked or cut, it does not react, unless by some reflex movements."

"The duration of the sleep may be very prolonged; we have some animals which have been kept asleep many times for over two consecutive hours without any alteration in their health. The establishment of the current does not seem to cause pain, for the animals do not utter a cry, aside from the contractions and contractures caused by the current, they do not make any movement of defence or of flight. If the current is established slowly, in order not to exceed the necessary dose and avoid contracture, there is a period of agitation, analogous to that which chloroform gives: the sleep is then longer to obtain. . . . In summary, with these currents, one can instantly, without apparent pain, bring about the complete inhibition of the cerebral centres, leaving intact the centres of respiration and of circulation; one thus obtains a tranquil, prolonged sleep, and a complete general anaesthesia. The somniferous action is regulated and is suspended as quickly as one can act on the electric current; the sleep is not followed by any consecutive reaction."

Later, Leduc arranged that the technique should be applied to himself, but his colleagues feared to push the experiment far, only 35 V. with a current of 4 mA. being reached. Leduc recorded his sensations as a complete loss of motor-power, and dimming of hearing and sensation generally. No pain as such was experienced, and he appears to have been incensed that the experiment was not carried further, believing that he would then have experienced complete anaesthesia. This belief is apparently supported by the work of Kalendaroff, but is challenged by Zimmern and by Hertz, as will be discussed later.

Robinovitch (op. cit.) reviewing the technique of this method, emphasizes that:

- (1) large storage batteries (100–200 ampere-hours) only should be used for current, as the latter must be steady.*
- (2) for the same reason the supply (to the patient) must be independent of that driving the motor of the interruptor.
- (3) self-inductance must be eliminated from the circuit, as by the use of graphite rheostats, etc.

Ross and Allen (1943) investigated electro-narcosis in dogs by a technique similar to Leduc's. Voltages up to 17 provided currents of 2–10 milliampères, interrupted mechanically from 80–470 times per second. Their results were essentially the same, and are summarized by them as follows:

"If before the stage of tetanic contractions is reached, or immediately thereafter, the voltage is dropped back slightly, a stage is reached whereby the dog continues to breathe slowly and evenly, there are no reactions to painful stimuli, no reflex movements and no corneal reflexes, although the eyes may be open and staring. At this stage there is no muscular rigidity. In general, interruptions of lower frequency are more sedative than those of

* This stipulation does not continue to apply to-day, when less cumbersome and costly stabilizing devices are available, such as the feed-back circuit described by Plesset (1942) and employed by the American workers (q.v.).

It is necessary over the whole field to recognize the distinctions between constant-voltage and constant-current conditions. The large storage batteries of Robinovitch, for example, provide only for constant *voltage*, and the current passing will depend on the very variable resistance of the animal, and on back-E.M.F. It is always the current-density that is the physiologically critical determinant.

higher frequency, although this effect is not easily discerned in all cases. This stage is difficult to achieve because of the apparent concomitant effect on motor nerves, but once arrived at, is maintained with ease for periods of twenty minutes or longer. Upon removing the animal from the effect of the current there is a period of hyperpnoea, but no evidence of pain, and the dog quickly returns to normal. Dogs which were watched for a period of several days thereafter showed no ill-effects. The subject carries such great implications that even the relatively meagre success to date still opens the way for much improvement. Further experimentation is still to be done at the higher frequencies* and under many conditions. It appears that there are still factors to be determined. . . . In conclusion, it may be stated that the optimal results, with the current employed, were obtained with 10 volts interrupted from 100 to 120 times per second, with very gradual induction† and **particular care required to avoid lethal potential.**"

Silver (1939) reports work on rats, and Silver and Gerard (1941) on the frog, rat and dog. Here continuous D.C. was employed. The cathode was inserted in the mouth and the anode in the anus, and a current of 10 mA. was passed. This resulted in rats in "a completely unresponsive state which could be maintained for hours." The animals were quiescent under severe noxious stimuli (cutting, burning, powerful electric shocks). When the circuit was broken (after halving the current for one minute and then reversing for 10 seconds‡) the rats recovered normal reflex thresholds within 5 minutes and complete normality within 10 minutes. Repetitions totalling 10 hours of treatment failed to lead to any detectable physiological defects or neuro-histological changes. In the second of the studies, where dogs were included, these findings are confirmed, and the authors conclude that a current-density of 1 mA. / mm.² of cross-section of the cord is required for the effect. Blood-pressure, heart-rate, and respiration were not significantly affected. In one dog the current was passed for a period of 8 hours without ill-effect. Complete recovery on breaking circuit was invariable, but considerably slower in the dog, though normal reflexes were present in 15 minutes.

Of special veterinary interest is the report of Kosler (1928) who employed an electric method in cattle. Direct current at 100-120 V. was passed between a copper electrode on the loins and a brass bit in the mouth; the current strength is not known. The animals sank to the knees and then to the side in lateral recumbency, with apparently complete loss of consciousness. Recovery was complete in 2-3 minutes of switching off. The procedure was repeated on the same animals without harm. Frickinger (1928) confirms these results.

Further studies with this type of current are considered under a later heading, but before leaving the present topic reference should be made to a communication from Professor Kalendaroff of the Biophysics Section of the

* The influence of frequency has since been studied in America (see p. 67) and in Italy (p. 58). But the conclusions arrived at are discordant.

† The recommendation of slow induction by these workers is not in accordance with Leduc (p. 54) and certain other workers (Wiersma *et al.*; Kalendaroff). In the light of Leduc's observations this may account for their difficulties, and perhaps the motor effects.

‡ No reason is given for this procedure, and its influence on the course of events is not indicated. Its rationale is presumably referable to back-E.M.F.

Institute of Experimental Medicine, U.S.S.R., for a copy of which I am indebted to Major C. W. Hume. The letter refers to a publication by Hume (1935) in *Nature*, and states: "We are trying electro-narcosis experiments not only with animals (frogs, rabbits, dogs), but also with human beings, both sound and insane persons. For this purpose we use Leduc's currents. . . . All experiments are verified on ourselves."

"We are thus able to produce: (1) a condition analogous to general narcosis with total unconsciousness, with loss of sensitiveness and motility; (2) a condition analogous to sleep, with integrity of reflex movements and loss of sensitivity; (3) loss of sensitiveness localized in certain domains with integrity of tactile perception and complete consciousness."

"The stage of narcosis depends markedly on the adaptability of the organism to electric current. By increasing the current step by step, very smoothly and slowly, a considerable current (5 mA.) could be applied without marked symptoms of electro-narcosis. A rapid increase of the current up to 5 mA. causes a deep narcosis." The letter then mentions certain therapeutic applications of the current, including ". . . the treatment of mental diseases, the excitability of the brain in this case being markedly changed."*

Unfortunately, further details of these investigations do not appear to be available in this country. Their special interest lies in the unequivocal declaration of the induction of both general and local anaesthesia by means of the Leduc current, with human (subjective) confirmation.

(4) *General anaesthesia produced by the application of electric current across the head.*

This is the technique commonly employed in electric stunning in abattoirs. It is also the technique of electro-convulsant therapy in man. In both cases the current is passed for brief periods, but recently the current has been applied in psychiatric practice across the head continuously for long periods. (Wiersma *et al*; Paterson and Milligan). A fundamental difference between the present issue and those previously considered is the high voltages and seemingly enormous amperages that are employed.

Electric stunning of animals.—This subject has received critical attention from numerous investigators (Hill, MacSwiney and Clinton (1932); Symes, Hill and Hobday (1932); Dryerre and Mitchell (1934); Regensberger (q.v.); Anthony (1932); Clark and Tweed (1932); Müller (1932); and others). Single-phase rectified, alternating and three-phase currents are variously employed, applied in the case of the first two across the head, in front of or behind the ears; in the last case between the base of the ears and the forehead ("Iwel" Electro-lethaler). The voltage is usually some 70–80 V. and the resulting current of the order of 0.5 to 1.0 amp. r.m.s. (Hill and MacSwiney). The time of application of the current varies considerably in practice from a few seconds up to half a minute, and on its withdrawal the animal either relaxes immediately or goes into convulsions followed by relaxation. For

* It is noteworthy that this reference to the use of electric current in mental disease antedates by three years the pioneer work of Cerletti and Bini (1938) on electro-convulsant therapy.

periods varying from one to several minutes it then has every appearance of complete insensibility and fails to react to painful stimuli.

Ivy and Barry (1931) studied the effects in dogs. They employed I.D.C. obtained with a segmented wheel from storage batteries, with electrodes placed in the ears. (Reference to their observations on spinal anaesthesia has already been made). The interruption rate varied from 100–200 pulses per second, the pulse duration from 1 to 3 msec., and the time of application from 5 to 15 seconds. They conclude their long series of observations as follows: "The various types of current used will stun dogs. . . . The most efficient current is one of 72 V. interrupted 6,000 times a minute and passing $3/10$ of the total time—each stimulation lasting 15 seconds. The average time elapsed before pain was felt* after this current was 4 minutes and 14 seconds. The shortest time was 2 minutes and the longest 12 minutes. The minimum effective time for application of the current is 10 seconds, the optimum being 15 seconds. . . . The stimulation serves to inhibit cerebral activity as judged by the loss of reaction to painful stimuli, and the absence of the drop reflex, climbing reflex. . . ."

The authorities cited earlier all assert that consciousness is lost, though almost all concede that this conclusion is presumptive.

Frostig, van Harreveld, Reznick, Tyler, Wiersma (1944) essayed a modification of this technique in dogs and man. 60-cycle A.C. was applied between electrodes placed behind the ears of dogs at such a voltage (unstated) as would supply a current of 300 mA., which was maintained for 30 seconds and then reduced to about 50 mA. (till respiration was restored. This they designate their "narcosis-level"). During the initial phase the usual tonic phenomena were produced, but with reduction of the current a condition of narcosis resulted in the majority of dogs "which could be maintained for hours." Recovery was complete within a few minutes of breaking circuit. In a minority of their dogs, what is termed a "hyperkinetic reaction" resulted instead of the narcosis, the characteristics of which recall the delirious phase of inhalation anaesthesia, in a modified form. This was partly dependent on the manner of induction, but is ascribed by them largely to idiosyncrasy, an aspect which is discussed later.

These workers used in these studies sine-wave A.C. from the mains instead of the traditional I.D.C., since earlier studies of van Harreveld and Kok (1934) and Wiersma *et al.* (1942) had indicated respectively that sine-wave current could be used, and that there was no significant difference in effect between this and square waves. These appear to be the first records of the use of A.C. for electro-narcosis (as opposed to stunning).

The objective of this team of workers was a modification of electro-convulsant therapy in psychiatry, and their results in the dog led them to apply the technique in human subjects. They report on over 100 treatments of 9 patients. The human reactions combined the narcotic and the hyperkinetic types of reaction in varying degree, but the techniques of induction were not entirely the same as for the dogs, and this might account, the authors think, for the difference. What is of special interest in their report is the observation that

* The form of this statement begs a very important question, to be discussed later.

"Consciousness was lost during the entire period of application of the current. . . . No patient complained of any unpleasant sensations during the electro-narcosis." Very dim memory was retained by some patients of the late or recovery stages. The treatment was sometimes maintained for as long as 30 minutes at a stretch. On termination there was a "prompt and speedy return of consciousness."

Reference has already been made to the findings of Gualtierotti, Martini and Marzorati (1942) in the context of spinal anaesthesia. In the majority of their studies these workers applied the Leduc-type (which they designate "Greek") current at the head either directly to the exposed brain, or by means of external electrodes, in cats, dogs and man. They categorically declare their confirmation of the original work of Leduc, with the exception of the question of the optimum frequency of interruption of the current, which they repeatedly affirm is at 280 cycles/sec., variations of as little as 15 cycles/sec. (approximately 5 per cent.) in either direction having a markedly reduced efficacy. This conclusion finds no representation elsewhere in the literature, either in respect of the frequency or the existence of so narrow an effective frequency-band (*cf.* van Harreveld *et al.* below). Their technique of application also differed from that employed by other workers, since they applied the current intermittently, for 30 seconds followed by 30 seconds withdrawal, and so on, to a maximum of 5 applications.* The reason for this practice is not given, but was presumably necessitated by their concomitant studies of the electro-encephalographic patterns which resulted. This team is the first to have invoked the electro-encephalogram for the (objective) study of the effects of the current on brain-function, and they describe, with reproductions, modifications of the normal encephalogram characterized sometimes by a complex sequence in time, and by representative slow waves and complete electric silence, likened to the phenomena in sleep and ordinary anaesthesia. It would appear that they have regularly succeeded in inducing states of true narcosis and anaesthesia, durable for hours, in both animals and man. No adverse effects or sequelae are described.

TRUE AND SPURIOUS ELECTRIC ANAESTHESIA.

That electric anaesthesia is a realizable possibility must be considered proven, but there has been acute controversy on the requisite conditions, and some of the comparatively recent literature even contains categorical denials of its existence and, indeed, its possibility. It is contended in these quarters that animals under the influence of electric current may be in a *nightmare state* wherein consciousness is maintained but motor paralysis prevents their evincing any movement or response to whatever stimulus, in very close analogy with the curarized state. Nor is the evidence by which this contention has been nourished by any means negligible. Regensberger (*op. cit.*) states the case clearly in his quotation of the remarks of a "Professor at North-Western University": "He stated that the conditions observed might be indicative

* This technique has representation elsewhere only in the studies of Leduc, who describes "cataleptic states" as a result of similar applications at 30-60 second intervals.

of consciousness, or they might simply denote lack of control of the muscles with full possession of the sensations . . . In consequence, the condition observed might be merely a temporary paralysis, with the animal retaining full sensibility to pain. The hog cannot squeal because the throat muscles will not respond, and it cannot run or walk because the muscles are out of control, but it may be aware of all that is going on." It would appear that this was Dr. A. C. Ivy, whose subsequent work on dogs, and his conclusions, have already been mentioned. Hertz (1933) of the Rothschild Hospital, Paris, may now be quoted in the same context (the electric stunning of swine): "En réalité, l'animal est stupéfié, car la phase stupeur précède la phase d'électrocution; c'est un cochon stupéfié, mais ce n'est pas un cochon anesthésié. Le bénéfice est certain pour les spectateurs émotifs, il est nul pour le cochon."

Hertz speaks on the authority of his own very interesting experiments in this connection. In general, however, there has been a lamentable lack of serious endeavour to clarify this fundamental issue (of the state of consciousness) by the experimental method. Moreover, in scrutinising the literature on both sides it is impossible not to suspect that the thinking is sometimes guided wishfully.

Thus Anthony (1932), in the context of stunning at abattoirs, quotes numerous authorities who have given it as their opinion that the animals are unconscious. This carries quite rightly negligible weight with the opposition, who can produce experimental evidence in the reverse sense.

Müller (1932) in a vociferous defence of the method of electric stunning, argues by analogy from human epilepsy, and by a number of stretched analogies from experimental work in this and other connections, he concludes that unconsciousness is determined in both cases by cerebral anaemia. "I should not speak in favour of electrical stunning for the purpose of humane slaughter if the complete unconsciousness and insensitivity of the animals so treated were not an actual fact . . . doubts merely denote lack of biological knowledge of the subject."

Roos and Koopmans (1934, 1936) who enter the lists against Professor Müller, sufficiently indicate their opinion by their invariable use of the term "so-called electric stunning." They rightly decry all argument by analogy between chemical anaesthesia and the electrically induced condition, and by physiological experiments (1936) demonstrate that absence of the eye-reflexes is no criterion of the state of consciousness in the electrically treated animal, since the effector side of the reflex-arc is out of action. The same, they argue, must be true of all the reflexes.

Zimmern (1933), in an address to the Société de Pathologie Comparée, repudiates the entire project of electric anaesthesia. His views are largely based on experimental work conducted by himself in 1903, after a visit to Leduc's laboratory. He declares the anaesthesia mythical and the procedure actually dangerous (deaths in 1 in 4 of his experimental dogs). "Nous avons en effet été amenés à conclure que le sommeil électrique n'existe pas, et que l'inhibition provoquée par les courants de Leduc doit être interprétée non pas comme sommeil mais comme manifestation de la série comitiale. . . .

Ainsi s'écroule tout espoir de l'adapter à la narcose chirurgicale. Ses dangers du reste suffiraient à l'interdire."

Stief (1933) has concluded from his experiments that "Electro-narcosis is not a narcosis proper but a complex of various symptoms, as drowsiness, unconsciousness, partial loss of tonus, catalepsy and stupor." He also records haemorrhages at the base of the brain and in the ventricles, and concludes that Leduc's current (which he says is conducted mainly by the cerebro-spinal fluid) is relatively dangerous.

Hertz (1933) conducted experiments of considerable import, on dogs and on human patients, using the Leduc current. The objective phenomena in both dogs and man were the same, and in his own words, "identique à ceux que Leduc et Roubinovitch ont décrits." To the observer, complete anaesthesia resulted, with steady respirations, relaxation, etc., under which (in the dogs) abdominal and other operations were successfully performed. "Nous avons été d'abord émerveillés par l'anesthésie apparente complète." It is noteworthy that Hertz does not seem to have found the method in any sense dangerous, as did Zimmern. He records no fatalities, or adverse consequences, and he proceeded to apply the method in a series of four human patients. Currents up to 25 mA. were used. All four subjects, while having the appearance of anaesthesia, are reported to have retained consciousness with various unpleasant features (sense of impending death, suffocation, etc.) and were able to relate where they had been pinched or pricked. Hertz concludes: "Il n'y a plus lieu à notre avis à discuter longuement. . . . Ce courant ne constitue en aucune façon un moyen de produire une anesthésie électrique comme cela a été dit par nos devanciers." He ends with a statement that similar current was applied to the limbs with a view to inducing regional anaesthesia, with completely negative results, failing to confirm Robinovitch and Kalendaroff (q.v.).

Finally, Hume (1936) and others have published data collected in respect of electric accidents, where the subjective experience of those concerned proves that unconsciousness is by no means a necessary consequence of contact with sources of even high-voltage electric power, and that where consciousness is retained the experience may be anything from unpleasant to agonizing. Naturally, a great variety of electric and physiological conditions are here concerned.

ELECTRO-CONVULSANT THERAPY.

This procedure, now in regular use in psychiatry, has so close a bearing on much that is at issue here, that brief reference to it is called for.

Technique.—50-cycle sine-wave A.C. at about 100 V. is applied for 0.1 to 0.5 seconds between electrodes strapped to the temples. The resultant current across the head is something of the order of 0.5 amp. r.m.s. The voltage requisite in each individual case can only be determined by trial. Where unusual resistance leads to an inadequate magnitude of current, a stunning shock (without convulsions) results. A summation of stimuli also is essential for the production of convulsions: a single pulse of whatever strength is inadequate and stuns only (Hemphill and Grey Walter (1941)).

This procedure differs electrically from that at abattoirs in that for the latter a long application with lower voltage is the rule.

The information derived from this practice and relevant to the present topic is as follows :

(1) The technique is simple.

(2) Memory of the shock is nil ; memory of the preliminaries are faint and " fade like a dream " (Fleming, Golla and Grey Walter (1939)).

(3) Fractures are now extremely rare with the improved technique (e.g. Hemphill and Grey Walter (1941) record more than 2,000 convulsions in more than 200 patients with no instance of fracture).

(4) Where a stunning shock only is inadvertently administered, immediate repetitions are practised in the hope of inducing convulsions. Batt (1943) employed in an exceptional case 26 successive stunning shocks without mishap, and repeated shocks are now in use as an amplified therapeutic measure (Milligan (1946)).

(5) Age *per se* is no consideration. Hemphill records the treatment of a 3-year-old child and Fleming a woman of 84. This is of special interest in connection with the following observation of Clark and Tweed (1932). Referring to the electrolethaler, they remark : " A suggestion has been made that the apparatus may be used to produce unconsciousness in animals for minor operations, but in view of the enormous strain on the circulatory system, the wisdom of this suggestion is doubtful." As the technique in question here is the same in every essential as that in man, this (purely theoretical) objection can hardly be sustained.

(6) As is well established, for some time after treatment, some of the most difficult patients are more tractable and co-operative. In this context the observation of Clark and Wall (1934) in respect of rabbits and cats may also be noted : " There was some indication that the application of the current made the animal quieter and more docile for a considerable time afterwards, and Hess (1931) also reports this effect. . . . "

(7) Unconsciousness lasts for some minutes after the shock. Apart from the subjective and objective evidence, proof of the existence of a state of true surgical anaesthesia is afforded by the fact that where dislocations occur, as is exceptionally the case, they may and should be reduced immediately, " while the patient is still relaxed and unconscious." (Barrera and Kalinowsky ; Hemphill ; etc.).

Through the courtesy of medical authorities,* the writer has had opportunities of witnessing both the standard routine-use of E.C.T. in man, and also the prolonged treatment for producing electro-narcosis after the manner of the American workers. The absence of apprehension on the part of the patients having had previous treatments, and many of whom from the nature of their case, e.g. anxiety-neurosis, might most be expected to exhibit it, is as impressive as the expediency of the method and general consistency of the reactions.

* I am indebted respectively to Dr. W. Ogden, and to Dr. Thomas Beaton, for their kind invitations to witness these routines.

For the electro-narcosis the current is the usual 50-cycle A.C. from the mains, but the apparatus incorporates a constant-current device, this being its only significant special feature. In the American method, after an initial 30 seconds at high voltage the current is dropped to the point where respiration recommences, this being characterized by a marked stridor, which continues for the 9 or 10 minutes of the treatment. It is necessary slowly to raise the current over this period (manually) to maintain the state of the subject.

Patients go into the usual tonus, with slight opisthotonus; this is maintained throughout. There is consequently no convulsion as such. The arms are held in flexor tonus which tends continually to become stronger, with the effect of raising the hands towards the face. The abdomen is not unduly rigid, and cutaneous sensibility is absent. It is stated that there is always an absolute amnesia—no memory whatever of the treatment is retained. This general picture conforms to the sub-kinetic type of reaction described by van Harreveld, Wiersma *et al.**

SOME THEORETICAL AND TECHNICAL CONSIDERATIONS.

Methods in both chemical and electric anaesthesia have originated and developed largely empirically. Chemical anaesthesia has yet to be placed on a secure theoretical basis, and the position in respect of electro-narcosis is even more obscure.

(1) *The cerebral circulation.*

As has already been mentioned, the loss of consciousness has sometimes been ascribed to cerebral anaemia. In this context, Ivy and Barry (1931), observing the cerebral vessels before and during the application of the current, failed to note any change in their calibre. Clark and Wall (1934), however, noticed constriction of the pial vessels and slowing of the blood stream for some 3 seconds after the current was switched on. This was followed by dilatation of the vessels on switching off, or if the duration of application exceeded 10 seconds. Van Harreveld, Tyler and Wiersma (1943) cite Jacobi and Magnus (1925) to the effect that during electro-narcosis the pial vessels are markedly dilated. Their own conclusion, based on a study of arterio-venous differences, is that during electro-narcosis the cerebral blood-flow is increased. As this relates to prolonged narcosis it would be compatible with the phenomena observed by Clark and Wall.

Certainly there is little evidence here to support the "cerebral anaemia" hypothesis protagonized by Müller; the indications are that ischaemia does not occur. In any case, Clark and Wall in the same studies were unable to induce loss of consciousness by a stimulation of the cervical sympathetic, which resulted in a greater constriction of the pial vessels than they noted when their current was applied at the head. It is, however, believed that cerebral anoxia, in consequence of the general anoxaemia which follows the apnoea or dyspnoea, may play a part in determining the change over from the tonic

* The term "electro-narcosis" must be considered most inept in this special reference. Narcosis is a well-defined clinical entity, with hardly anything in common with the state under present consideration, which features neither muscular relaxation, nor a state from which the patient can be roused. "Prolonged electroplexy" would be a far more apposite term.

to the clonic state, and the ultimate decline of the latter (Hemphill and Grey Walter (1941)).

All the above workers are agreed that the effect on the blood-pressure is an initial brief fall followed by a marked rise, after which there is a slow decline to the normal level. That the fall in blood-pressure has no bearing on the loss of consciousness was demonstrated by stimulation of the vagus, which resulted in a parallel fall without unconsciousness (Ivy and Barry).

(2) *Physiological effects on the nervous system.*

According to Kovaks (1944), "the Leduc current . . . exhausts the sensory perceptions." Evidently this authority ascribes the effects to fatigue. Van Harreveld, Tyler and Wiersma (1943), on the other hand, while ascribing the results to stimulation, posit that it is by stimulation of the inhibitory mechanisms, a thesis materially supported by the Italian workers.

On *a priori* grounds, several possibilities seem to merit consideration, nor does it seem necessary to assume that only one mechanism is implicated. With interrupted D.C. or A.C. current these are

- (1) a maintained refractory state of the neurones ;
- (2) the reflex-fatigue of Sherrington ;
- (3) stimulation of inhibitory apparatus ;
- (4) failure of central integration ;
- (5) polarization effects.

Where continuous D.C. is concerned, (4) and (5) may be relevant, and it may be wondered whether electrotonus has some possible bearing on the case. These factors will be very briefly considered, *seriatim*.

(1) *Maintained refractory state.*—Where the period of the fluctuating current is shorter than the shortest refractory period of the nerves concerned, and provided that the strength of the stimuli is adequate, it may be anticipated that anything up to complete block of the natural pulses will result, since these arrive only at nerve that is refractory. Such an effect might be anticipated throughout the nervous system, but the affective consequences must be expected to differ at different levels, as will be noted below.

Where the peripheral nerves are concerned this could in itself account for the loss of normal sensation. But it merely substitutes artificial and extremely vigorous electrical stimulation of presumably all fibres, for the natural pulses generated by the receptors. While the latter and normal sensation are thus admittedly cut off, the substituted affective result may be any degree of sensation from faint tingling to unendurable pain, depending on the density and frequency of the current, and it is not easy to see how satisfactory local or regional anaesthesia can be obtained with pulsating current on any such basis, though Robinovitch and Kalendaroff both describe it. Current that could block the pain fibres by pre-emptive stimulation must be expected to cause pain, and of considerable degree. Some such difficulties are evident in Robinovitch's reports.

In contrast, none of the evidence, subjective or otherwise, indicates that the passage of considerably stronger currents than could be supported peri-

pherally, gives rise to any degree of pain as such at a higher level, as when traversing the spinal cord. At the level of the cerebrum such strong currents cause definite loss of consciousness, but the importance of the present consideration at this level is indeterminate. Other effects become possible at this level and in the spine.

(2) *Reflex fatigue*.—Thus with stimuli at the frequencies in question, it is difficult to believe that there will not be very rapidly induced at least some degree of reflex (synaptic) fatigue. Such fatigue, as both Sherrington and Adrian have pointed out, almost certainly plays a large part in the normal flux of 'sensation in consciousness. If, as seems probable, it obtains with the Leduc and other currents, this may be expected to lead to at least a general diminution in the intensity of the sensations,* or as Kovacs expresses it "an exhaustion of the sensory perceptions." It would follow, if this is the dominating mechanism, that the decline in sensibility should be progressive, and measureable in time.

(3) *Stimulation of inhibitory mechanisms*.—The hypothesis of van Harreveld and Wiersma that the root mechanism is a maintained stimulation of the inhibitory centres does not seem to be readily compatible with those just considered: indeed they appear to be mutually exclusive. With these workers, however, the current was passed not in the length of the cord but across the head, and the mode of action here might be entirely different. At all events impressive support would appear to be lent to their particular theorem by the studies of the Italian workers.

As the American workers point out, such stimulation (of the inhibitory centres) may be expected to dominate the picture to the exclusion of simultaneous excitatory effects, in the same manner as, for instance, the knee-jerk is inhibited by ipsilateral pain. Moreover, several workers have commented on the hypnosis-like features of the narcosis; and cataleptic states were recognized and demonstrated by Leduc,† and have been described by others (Stief, van Harreveld, etc.). Inhibitory mechanisms might well be particularly important in the context of muscular relaxation and of the failure sometimes to obtain this (van Harreveld; Ross and Allen), which is believed by van Harreveld to be an idiosyncrasy of the individual.

This last conclusion is interesting and suggests that such idiosyncrasy might be equated with the relative development and functional state of the inhibitory centres in individuals. It cannot be doubted that these vary enormously, not only between individuals, but between breeds and species also. It is necessary only to compare the innate behaviour of the pointer breed of dog at work with that, for example, of a terrier in the same circumstances, to appreciate this innate difference in constitution.

Between species it may be anticipated that such animals for example as the hare, and to a less extent the rabbit, the rat, and indeed all species in which immobility is an important defence mechanism, possess inhibitory centres

* Such an attenuation of sensation was a major component of Leduc's personally recorded experience.

† As has been stated earlier, Leduc obtained this effect by applying several separate excitations at intervals of from 30 to 60 seconds.

that are very highly developed, and it is all such as these that should, in terms of the theory of inhibition, go most readily into the narcosis. Van Harreveld worked on dogs, and a study of the responses ("narcotic" and "kinetic" respectively) with reference to breed, temperament, age, etc., might be illuminating. It may be worth noticing in this connection that the human patients on whom he reports, and who generally exhibited sub-kinetic behaviour under the narcosis, are described as schizophrenics of long standing. He has concluded that this kind of reaction is the normal in man. The possibility that it might have been the consequence of a perhaps constitutional, and certainly well-established abnormality, can surely not be totally ignored.

(4) *Failure of central integration.*—Whatever may be the importance of the foregoing factors, it can hardly be doubted that wherever electric current of threshold strength traverses the central nervous system there will be failure, partial or complete, in the processes of integration. It is a matter of common experience that the conscious sensory pattern, including the apprehension of pain, is always to a large extent and may sometimes be entirely dependent on circumstances and the psychological desiderata. As Livingston (1943) emphasizes, pain is a subjective phenomenon consequent on highly complex integrative activities in the cord and higher centres, with a strong affective element. Where the currents in question are passing, the effect is presumably a continuous, indiscriminate, undifferentiated stimulation of all the nerve-elements, including those normally concerned with the correlation and integration of the whole complex of normal sensation. It seems not unreasonable to suppose that a state of integrative chaos (a true *delirium cordis*) may ensue, defying all interpretation at the higher levels: and that the net result, being sensibly indeterminate, may be relatively indifferent in consciousness.

(5) *Polarization effects.*—The extent and significance of polarization effects in the cord can hardly be assessed. Where, on the other hand, the brain is concerned, as in stunning and E.C.T., no electro-encephalogram is possible for 20 seconds after heavy current has passed; the brain becomes like a battery, with polarization effects long after (Fleming, Golla and Grey Walter (1939)). It is only to be expected in such circumstances that cerebration should be completely suspended and consciousness lost.

Before leaving this issue, it may be noted that Burge *et al.* (1936) state that the cortex is electro-negative in respect to the exposed sciatic nerve, in the conscious animal, but that in chemical anaesthesia it becomes electro-positive. This polarity is freely reversible, and the phenomenon was observed with a number of anaesthetic agents, and with asphyxiation, haemorrhage, and the exhibition of CO₂. It is suggested by these workers that the brain behaves like a storage-battery, and that there is a threshold potential-difference which determines consciousness. While this is no doubt an over-simplification, their observations in respect of the polarity of the cortex may bear on the effects of heavy current on the cerebrum and consciousness, and the significance of the polarity of direct and pulsating current.

Anelectrotonus.—Whether electrotonus could play any part in the course of events with steady D.C. the writer is not qualified to say. It would appear to depend on whether currents of sufficient strength can pass. It is noteworthy

that the current strength required for D.C. to be physiologically effective is of a very high order as compared with that required for varying current. Thus Silver estimated it at 45 mA. for the dog, and 1 mA. per mm.² of cord, which would probably be fatal with I.D.C., while van Harreveld and his colleagues declare that in dogs "even . . . 500 mA. maintained during the entire experiment causes the same symptoms and does not endanger life." These last workers ascribe this difference in level for D.C. to its poor stimulating powers. It seems not impossible that a different mechanism may be involved.

Gualtierotti, Martini and Marzorati (1942) publish the only paper in the literature recording a direct experimental approach to the question of the physiological mechanisms concerned. Applying micro-electrodes to the exposed central nervous system they found that direct stimulation (with I.D.C.) in the region of the diencephalon (hypothalamus) constantly resulted in narcosis or anaesthesia. They claim moreover that separate centres exist effecting inhibition of function in the cerebrum, in the cerebellum, and as has already been mentioned, in the spine. The action of each centre is diffuse over its respective sphere—the entire anatomical unit is inhibited, as is demonstrated by electro-encephalograms, electro-cerebellograms, and electro-myelograms, as the case may be. The action is in no way reciprocal—stimulation at any other point results in nothing more than strictly and narrowly localized effects, while stimulation involving the pre-central motor-area resulted constantly in the motor activity to be expected. The mechanism in each instance they consider to be reflex.

The importance of these findings if they are confirmed needs no emphasis. They would seem to provide a complete explanation of the narcosis and seem fundamentally related to the now classical demonstration by Hess (1931) of a specific sleep-promoting centre similarly situated, no less than to the well-known narcoleptic consequence of tumours in the region of the third ventricle. It has to be pointed out, however, that the thesis that the effect results from clear-cut and direct inhibition by positive activity of the centres in question is not proven. There remains the alternative that the centres act not by the diffuse emission of afferent inhibitory stimuli, but by the total suppression of afferent stimuli, without which cortical activity may possibly suffer automatic extinction (Samson Wright (1947)). Indeed some additional weight is lent to this alternative in consideration of the fact that the currents used for these studies were of enormous magnitude (for currents applied direct to the central nervous system) such as might well be expected to dislocate the regional nuclear function rather than effect the hypothesized physiological stimulation, a consideration which may not be independent of the remarkably prolonged effects recorded.

(3) *The Influence of the form of current.*

For electro-narcosis (as opposed to electric stunning) the form of current used has been, almost without exception, the I.D.C. of Leduc, and in exceptional cases it has been D.C. With I.D.C. most workers report the best results with a current of pulse-frequency 100 per sec. and duration 1 to 3 msec.

The work of van Harreveld, Tyler and Wiersma already referred to included a study of the comparative effects of D.C., I.D.C. and A.C., and the influence of frequency and of duration of pulse. In all cases the current was passed across the head in dogs. The I.D.C. was thyatron-generated square-wave, observed and measured with an oscilloscope. Their findings are summarized below :

(1) For I.D.C. —(a) The strength-duration curve resembles that of peripheral nerve with a chronaxie that implicates the fast fibres (about 0.14 msec., rheobase about 100 mA.). (b) The pulse-duration is of small consequence down to 0.5 msec., when the threshold rises rapidly (the recurrence frequency was 120 per sec.). Pulse-duration has no influence on the course of events or symptoms.* (c) The interruption-rate is unimportant.† Above 1,000 per sec. there is some increase in threshold (ascribed to polarization effects), and above 500 per sec. the narcosis was commonly less tranquil.

(2) For A.C.—(a) The strength-frequency curve resembles that for peripheral nerves (para-resonance type). (b) All frequencies between 30 and 8,000 were effectual, but the narcosis was less tranquil between 500 and 2,000 cycles per sec. (c) The threshold minimum is about 100 cycles per sec., rising rapidly above this value (the threshold at 8,000 is 10 times the threshold at 100). (d) "The symptoms of en. [sic] produced with A.C. are identical with those produced with pulse current," a conclusion discussed below.

(3) D.C. also is effectual, but it requires a considerably higher amperage, and recovery is slower.‡ During the flow of the current they observed torsion of the head towards the positive pole, and after some time a tendency to roll towards that side (galvanic vestibular reflex); on breaking circuit the effect was to the opposite side, a phenomenon explicable in terms of back E.M.F.

It must be remarked that the source of D.C. in the American experiments was the laboratory mains with an admitted ripple of 1.5 per cent., which was considered "physiologically unimportant." At the lowest current passed this would entail variations of 2 or 3 mA. And at the highest, 500 mA., which was sometimes passed during the entire course of the narcosis, 7.5 mA. is involved. Robinovitch, as was stated earlier, is insistent that the source of current must be entirely steady for good results, and specifically vetoes the mains for the purpose, if only on account of the unreliability of their regulation. A variation of as little as 0.5 mA., she says, may suffice to cause trouble. This is a higher *proportion* of the current used by her than the proportion of ripple in the current used by van Harreveld, but it may be wondered whether some of the excitatory and other effects observed by the latter might not be due to this ripple.

The conclusion of these workers that sine-wave A.C. is physiologically the complete equivalent of I.D.C. of square wave-form is not a little surprising in view of the universally accepted belief that the square wave is a *sine qua*

* This conclusion is not universal; e.g. Ivy and Barry describe the best results with a pulse-duration of 3/10, a conclusion conforming well with that of the Italian workers.

† This result also is unsupported elsewhere. Most workers ascribe the best effects to a frequency of 100 msec. As has already been mentioned the Italian school insist that 280 msec. is uniquely superior.

‡ This conforms with the observations of Silver and Gerard.

non for good results, and indeed that goodness of the results will be proportionate to the rectilinearity of the wave-form (Robinovitch ; Ivy and Barry, etc.). Another surprising feature of their work is that their stated minimum current-strength for I.D.C. (some 100 mA.) is twice their minimum value for A.C. (approximately 50 mA.), for it is well-known that a sharp wave-front connotes far greater physiological activity than a smooth one, and as Hume (1935) has pointed out, the requisite current strengths for stunning with I.D.C. and A.C. are as 1:20. If the I.D.C. values are maximal,* and the A.C. are r.m.s., the difference does become less, but it is still the reverse of what might be anticipated.

The American observations on electro-narcosis, however, are thrown out of line with the rest by the use of (*a*) unusually high current (*b*) traversing the head only, and (*c*) maintained after an initial stunning current some 6 times greater, passed for 30 seconds. This last feature complicates the picture since "it is . . . possible to abolish the polarizing elements with strong current and to show that they require some hours to recover their properties" (Grey Walter).

In conclusion the work of Dénier (1938) requires mention. He has concluded that A.C. is rectified by passage through the tissues, giving an effect the equivalent of D.C. pulses, "which are probably more effective than A.C. in producing and sustaining either excitation or depression." Dénier is also quoted to the effect that the chief component of the impedance offered to the passage of current is the capacitative component in the impedance of the skin. The resistive component may thus be short-circuited by the use of higher frequencies. He states that the contractures resulting with low-frequency I.D.C. can be avoided by the use of higher frequency of period 1.5 msec. and a pulse-duration of 15 to 25 microseconds.

POSSIBLE DANGERS.

(1) *Damage to the central nervous system.*—Although the currents concerned in stunning in E.C.T., and for narcosis with the American workers, are nominally high (up to and even exceeding 1 amp. r.m.s.), the density of the current within the nervous tissues is, of course, much less. By reason of its vascularity the conductivity of bone is high, probably approaching that of saline, while that of the cerebro-spinal fluid is even better. In consequence of this and of dilution in the other tissues, the current-density in the brain is reduced in man at least 100-fold (Fleming, Golla and Grey Walter (1939)). In animals, where the brain is relatively smaller, the bones are more massive, and the temporalis and other muscles are interposed, the dilution will necessarily be greater.

Opinion is not decided as to the precise physical effects of the current on the nerve tissues (Barrera and Kalinowsky (1944)). Some observers can observe no histological abnormalities ; others describe a number of histological

* This is indicated by their measurement on the C.R.O. A major difficulty is created throughout the literature by the failure on the part of the majority of workers to specify their metric procedure. The quantitative data have little meaning otherwise, and where, as is usual, I.D.C. is concerned, the omission makes them valueless.

changes. The consensus of opinion would seem to be that such changes may be produced are largely reversible, and clinical experience amply demonstrates that no lasting damage is brought about. Moore (1943) discussing maintenance therapy involving sometimes well over 100 treatments in man, observes: "Clinical observation shows no appreciable deterioration in personality or intelligence as a result of continued therapy." Milligan (1946) recording results with the "intensive method" in E.C.T., originated by Beaton, describes as many as 3 and 4 convulsions per day, and with an average voltage as high as 180 V., and daily repetitions. These were for the treatment of psychoneurosis, and excellent results, with case-discharge, are reported. If these data apply in man, the question of deleterious effects in animal patients can hardly arise.

(2) *Electrocution of the patient*.—There is, in even the well-educated public and sometimes in the professions, a surprisingly potent streak of what can only be termed "electrophobia." Doubtless the association of ideas with the electric chair, and the occasional domestic accident, combined with misapprehension of the facts, are responsible. Indeed it is probable that this has played no small part in the strange neglect of the whole present topic.

Death by electrocution may result in three ways (d'Arsonval, quoted by Zimmermann (1933); Curtis and Cole (1944)): (1) by direct searing action on the nerve-tissue, as with extremely high current (e.g. lightning); (2) from ventricular fibrillation (syncope); (3) by respiratory paralysis (suffocation). We are here only concerned with the last two of these. As regards ventricular fibrillation, this can only result where the current traverses the heart. According to Curtis and Cole (1944) the vulnerable moment is 0.1 seconds before ventricular diastole, when electrical currents as little as 25 mA. may institute the fibrillation, which is, of course, generally fatal, though normal action may sometimes be restored by an appropriate second shock. It is for this reason, of course, that alternating or interrupted current is commercially so much more dangerous than direct current, since the possibility of the stimulus coinciding with the susceptible moment in the cardiac cycle is so much greater. But this issue is not relevant to the question of the anaesthesia, since in no circumstances does the current-path lie across the myocardium (see, however, the discussion of the electrolethal chamber below).

The only danger pertinent to the question of anaesthesia is the third possibility, respiratory paralysis, which is in fact the commonest cause of electrical fatalities in man; and respiratory paralysis is a regular feature of the electro-narcosis—the current is increased to the point of respiratory arrest, and the narcosis-level lies at a value just below this, where the respirations are deep and regular.

It is well known to-day that the treatment for respiratory arrest of electrical origin is artificial respiration, which is successful in a high proportion of cases and even after very severe shocks. It is manifestly a risk which, if not entirely negligible, is present in considerably less degree than in the use of the ordinary chemical anaesthetics.

(3) *Danger to the operator*.—The possibility of danger to the person operating stunning or electro-narcotic apparatus may assume undue proportions in the

minds of the electrically innocent: it is in fact hardly real. With properly designed and constructed apparatus and the incorporation of common-sense safety devices it vanishes to zero.

(4) *Other effects*.—Zimmern has declared the Leduc current and technique highly dangerous on account of respiratory failure, and he also reported systemic effects, notably pulmonary haemorrhage and oedema, in his dogs.* Ross and Allen observed that in some of their dogs "the margin between the lethal voltage and the optimal voltage was very narrow," and evidently care and discretion was needed in their case to arrive at the correct setting. This, however, is a generalization true for all anaesthetics, and the disastrous general effects described by Zimmern find no recognition elsewhere. They were not noticed by Ross and Allen. Ivy and Barry had no casualty in their total of 40 dogs, many receiving several treatments. Hertz felt justified in applying the currents to human patients (and Leduc to himself) without fatality. Van Harreveld and his colleagues employed heavy currents for as long as 30 minutes in dogs and man, this last involving a series of 9 patients and over 100 treatments, with no disaster. No doubt the danger of fatalities may be greater in the use of the Leduc-technique, where the current path is in the entire length of the C.N.S. and hence includes the respiratory centre. For transverse A.C. across the cerebrum, however, the clinical records of the routine use of E.C.T. in man provide overwhelming proof of the general safety of the procedure (see Kalinowsky and Hoch (1947)). It can only be concluded that the proper procedures are essentially safe, but that Zimmern's technique (and presumably also Stief's) was in some way at fault.

The only danger in these methods that seems to have any claim to recognition is that of bone-fractures. Though these have been virtually eliminated in man with the modern techniques of E.C.T., it has been accepted in the past that they are associated with powerful musculature (Hemphill and Grey Walter (1941)), although this has been contradicted elsewhere (Cook and Sands (1941)). They have, however, been the consequence of electric stunning in pigs (Anthony (1931)), usually involving the neck of the scapula or the thoracic vertebrae (as in man), though their incidence is given as a fraction of 1 per cent. (Anthony). The evidence on all sides indicates that their elimination is a matter of (a) complete freedom from restraint and (b) the correct electro-technology. There is no record of their occurrence in dogs or any of the other experimental animals used, but in large and powerful animals there is reason to anticipate this complication, which is present in any case in the horse with ordinary anaesthesia. The degree of risk, and the possibility, if it exists, of eliminating it by proper techniques of application in respect of the large animals, have yet to be determined.

GENERAL DISCUSSION OF ELECTRIC ANAESTHESIA: PRESENT USAGES AND THE POSSIBILITIES.

Electric current is already widely used as a general anaesthetic in pigs prior to their slaughter. It also has increasing use for the destruction of

* The most probable explanation of at least the oedema would be anoxia of the pulmonary endothelium, implying prolonged hypopnoea or other interference with the oxygen intake.

dogs and cats. It remains to examine its employment in these ways, and to consider briefly the possibilities of its more extensive use in the field of anaesthesia.

Consideration of the available evidence seems to justify the following conclusions :

(1) Electricity can be a potent anaesthetic agent.

(2) The conditions for its effective action in this sense are imperfectly understood, but for general anaesthesia two pre-requisites may be affirmed : the current must traverse the brain ; and it must be of sufficient magnitude.

(3) When the current fails to attain the strength required for anaesthesia general paralysis of the motor system antecedes an equivalent effect on the sensory side, and the objective phenomena may then have every resemblance to true general anaesthesia, whereas in reality a state obtains comparable in effect with curarization, of motor paralysis without, or with imperfect, suspension of sensation.

It follows immediately from the last conclusion that none of the standard objective tests of the state of consciousness applicable in general chemical anaesthesia is valid here. This fact must be recognized as entirely crucial to the whole issue. It means, for example, that none of the careful studies on animals recorded in the literature, where the persistence or otherwise of the various reflexes and the exhibition of painful stimuli have been the basis of the investigation, has any real relevance or significance. It means, moreover, that objective methods of an entirely different kind must be invoked, such for example as a study of the behaviour-patterns in animal-subjects in terms of their conditioned responses, or the use of electro-encephalography. The latter technique, while it is very reliable in such contexts, has the practical limitation that it is not applicable during the actual passage of the current.

Serious technical difficulties are, of course, implicit in any study of the state of mind and consciousness in animals. In the present context, direct observations under conditions of experiment of the subjective state in man are obviously the most decisive.

Electricity for the stunning of animals prior to slaughter.

The above considerations apply with full force in the use of electricity at the abattoir. The conclusion is therefore forced that we know very little indeed of the true requirements. Hume (1935, etc.) in several papers, has repeatedly questioned the validity of the criteria in use, but his thesis has so far received scant attention by the responsible authorities, though critical and unbiased examination of the position reveals every reason for his doubts of the adequacy (in the humane sense) of the sanctioned procedure.

It might be thought that the fact that the head of the animal is invariably in circuit affords a guarantee of the induction of unconsciousness. This, however, does not follow, for it is also requisite that the magnitude of the current passed shall be adequate. And it is a relevant fact that the voltage applied in pigs is considerably lower than that used in the (otherwise comparable) practice of E.C.T. in man. In man, voltages upwards of 100 are applied, whereas in the abattoir, voltages of the order of 70 are preferred,

since the higher rating (employed initially) was found to result in bone-fractures, which depreciate the value of the carcase on account of the consequent haemorrhage (Anthony (1932)). This important difference vitiates comparison between the two procedures, because even assuming that the electrical resistance is the same in man and the pig, the current density in the case of the pig is not less than 30 per cent. lower, and approaches the threshold value for effective action.

It is this lower voltage that necessitates the considerably longer application of the current in abattoir practice, in accordance with the strength-duration requirements discussed by Hemphill and Walter (1941), the formal practice being to retain the electrodes in position for some 10 seconds or more. This in itself must be considered a dubious recommendation from the humane angle, and it is evident from the reports of more than one of the official scientific adjudicators of the method that they consider the time factor both critically important, and liable in practice to receive too little respect (Dryerre and Mitchell (1934)).

The present writer would go further, and say that this particular feature justifies condemnation of the procedure described. For if the above premises are admitted, and they are hardly controvertible, common-sense reasoning suffices to prove the method inhumane in a significant proportion of animals. Accepting for the sake of argument that the procedure followed provides adequate anaesthesia in the majority of pigs,* and recognizing also that the electric resistance of animals varies widely not only with size, but with the individual constitution of the animal, it is only necessary to correlate the requirements of the case with the general routine of the slaughterhouse to realize the inevitability of failure in a proportion of the pigs slaughtered. Now, the period of application of the electrodes is in actual practice left entirely to the discretion of the slaughterman. It follows inevitably (1) that this being a matter of judgement, the human element will determine a number of failures in all sizes and conditions of animal: (2) that from the nature of things, this time-period *will be computed in terms of the average animal*: (3) that human nature and commercial requirements being what they are, this period will furthermore tend towards the minimum, a tendency which will be aggravated by conditions of piece-work.

These formulations can lead to one, and only one, conclusion: that in the case of all animals having a higher resistance to the passage or action of the current than the average (low average), the humane requirements will not be met. These animals certainly suffer motor paralysis, but they are not anaesthetized.

Thus the remarks of Hertz in this connection (quoted earlier, p. 59) become entirely true; it is the curare-like action of the current that is being exploited in these subjects. And it is notable that this is done with full authoritative sanction, in spite of the fact that the Home Office (quite rightly)

* For humane requirements to be satisfied it is necessary that anaesthesia should not only be complete, but endure over the period of time required for slinging, sticking, and for the animal to bleed-out sufficiently. In the last context the fact that the animals are suspended head downwards during this time must be recognized as providing the maximum delay in loss of consciousness by the bleeding.

maintains the most rigorous control of the use of curare itself on animals, with a system of supervision that is, in effect, almost prohibitive of its use. It should further be emphasized that whereas curare *per se* has only motor-paralysant effects, sub-anaesthetic doses of electric current have the property both of effecting motor-paralysis and inflicting very considerable pain. Those practising E.C.T. on man are only too well aware of the unfortunate consequences of the accidental administration of inadequate electric dosage, which can permanently prejudice patients against further treatment. According to Golla, Grey Walter and Fleming (1940) the range of electric (ohmic) resistance in man, after the normal reduction in value which follows the passage of a few cycles of current, is approximately 33 per cent. of the average, so that the difference between the most and the least resistant subjects is as 2:1, to which is also to be added the variation in physiological susceptibility, (independent of ohmic resistance). Assuming, in the absence of specific data, that circumstances are comparable in the pig, it follows that the ohmically resistant subjects can receive as little as 50 per cent. of the current received by the least resistant, and 33 per cent. less than the average, who, as stated above, are themselves receiving only threshold values. The necessary inefficacy of the procedure in this proportion of animals is self-evident.

It requires only a visit to, and critical observation of, the actual course of events at any slaughterhouse where the electric method is in use to be convinced that the state of affairs realized in practice is exactly as described; nor is it possible to see how it could be otherwise with the practice described. It could even be argued that in many cases humane considerations would be better satisfied if the pigs were stuck with no electric preliminaries.*

If humane considerations are to be ignored and expediency is the sole consideration, the situation prevailing is eminently satisfactory. If, however, humane questions are to be admitted, the methods in use require the earliest possible revision.

Several of the modifications requisite have already been specified by Hume (*loc. cit.*). The procedure should provide by law for the following:

(1) An ammeter in series with the animals should be an integral part of the mechanism, both to monitor its performance, and to ensure that in all cases an adequate volume of current is passing. This fundamental requirement is never met, despite the well-known tendency of these machines to deteriorate in the constant use to which they are subject.

(2) *The period of application of the current should not in any circumstances be the responsibility of the slaughterman.* It should be controlled mechanically by a time-switch set to provide for anaesthetization, in terms not of the average animal, but of the most resistant, its operation to be signalled to the slaughterman by a pilot-lamp, and it should be illegal to operate the mechanism otherwise. This would be an innovation which would, of course, slow down the work by several seconds per pig, and its introduction would no doubt evoke corresponding commercial resistance.

* It should be borne in mind that the alternative method of slaughter by shooting with the humane-killer is unquestionably humane. But certain commercial objections have been raised against it.

(3) Provision for the passage of a constant level of current, independent of the resistance of the individual subject, and of a magnitude to be prescribed in the above terms, should properly be made. For this purpose the use of barretters, as suggested by Hume (*loc. cit.*) should serve the requirements of the particular case satisfactorily, at little expense.

The electrocution of dogs and cats.—Electrocution promises to supersede all other means for the destruction of dogs and cats, particularly at the large clinics and centres. It has great intrinsic advantages over other methods, being clean, economical to run, silent, bloodless, uniquely convenient, and operable by unskilled persons.

It might be thought that the electrocution of dogs and cats is germane to the topic of electric anaesthesia. Such, however, is not the present position, for no question of anaesthesia enters in. The avowed objective is not primarily unconsciousness, but death by heart-failure as the result of the institution of cardiac fibrillation. The animals are deposited in a chamber and the current passes either (1) from a metal collar around the neck through the body to a metal shackle secured to a hind leg; (2) from a metal neck-collar through to the four limbs which rest on a platform constituting the second electrode; (3) in the cat, the current is passed between the fore-limbs and hind-limbs, which rest on separate platforms constituting the two electrodes. The heads of the animals are in all cases out of circuit.

Hume has, in this context also, contributed several papers (1935, etc.) in which he questions the propriety of the general technique. He argues on the basis of the studies of Kouwenhoven and others (1930, etc.), and of Ferris, King, Spense and Williams (1936) on electrically induced cardiac fibrillation, that the requirements for fibrillation are strictly determinate, both electrically and physiologically, and that the guarantee that these requirements are met under the conditions obtaining in practice are inadequate.

This thesis is not without considerable scientific justification. It is equally certain that any method of destruction of dogs and cats, and having application in hundreds of thousands of cases per annum, demands the closest scrutiny if its humane principle can be called into the least question.

Fundamental to the issue are the facts that (1) contrary to public belief, unconsciousness is by no means implicit in the passage of the electric current through the body, as is amply demonstrated by the data presented in this paper, by the evidence adduced by Hume (1935) of subjective experience in cases of industrial accident, and by the observations of Zimmern (1933) and others in the same context; (2) that the passage of currents of any magnitude, where consciousness is not abolished, involve extreme degrees of pain, both by direct stimulation of the nerve-elements, and by reason of the muscular cramp which results. As Hume protests, unless the animals electrocuted suffer *immediate* syncope and extinction of consciousness in all cases, it must follow that they are being subjected to a preliminary period, of indeterminate length, of electrical agony.

Such a possibility (if indeed it is not a probability), must be considered a very disturbing one by any who have the least interest in the humane treatment of animals, and it is deplorable that it should have received so little serious

attention by those practising and protagonizing this method of destruction. No adequate attempt to clarify the issue by experiment has been made, and it therefore continues to remain in doubt, after nearly two decades of use involving several millions of animals. It has to be concluded that the convenience of the procedures in question has been a recommendation over-riding all other considerations.

It may be declared that it is in the cat that the method is most open to question. And the fact that the official prescription for destruction in these animals is in application of the current for 45 seconds, must be considered in itself a highly dubious and significant circumstance.

In the present writer's view, however, Hume's protestation is itself mistaken to the extent that it seeks to improve the technical provision for the induction of the ventricular fibrillation, because *it is the selection of this as the sole and root mechanism of death that is the fundamental fallacy.*

The first principle in euthanasia, and the attainable ideal, is that consciousness shall be instantaneously and with certainty abolished. Once this is reliably provided for, the actual mechanism whereby death is accomplished becomes a matter of free choice, to be decided in terms of reliability, convenience, economy and the aesthetic considerations. The present practices put the cart before the horse. They aim to arrest the heart and thus abolish consciousness, whereas the obviously proper objective is the exact reverse—to abolish consciousness and then arrest the heart.

All the scientific evidence affirms that the passage of a sufficiently heavy current through the brain connotes instantaneous unconsciousness. It is the deliberate exclusion of the heads and brains of the electrocuted animals from the pathway of the current that is the primary technical error. If this modification in the technique were made, no objection whatever to the electrocution could be sustained (with the proviso, as required at the abattoir, that an ammeter be supplied as an integral part of the machine, to establish in every case that the current passing is adequate*). In the dog this change would involve no more than the substitution of a simple adjustable muzzle for the neck-collar in present use. In the case of the cat, a complete revision of technique is demanded. The application of the current between pairs of limbs has no possible justification or desirability except that of its supreme convenience for the operator. The humane requirement is the provision of a platform constituting the live electrode covered by *thick* absorbent matting, properly wetted; and a head-collar of design permitting easy attachment and rapid, firm adjustment. This head-electrode should be earth-connected and be affixed after the animals have been placed in the chamber; and the chamber could be so constructed as to allow for the easy and comfortable protrusion of the animal's head only. In the very exceptional case where the animal's behaviour might make the proper application of the electrode to the head difficult, alternative methods of destruction should be invoked.

The proposed changes in technique would bring the electrocution of these

* This is again a regular omission, which it is difficult to understand, and a point repeatedly raised in Hume's papers. No electrical engineer would dream of issuing a machine for, e.g., commercial use, and in which the magnitude of the current was of critical importance, without incorporating a meter. Nor is the component expensive.

animals into line with that of penal execution in man, with which at present there is no legitimate analogy to be drawn.* It remains, however, to suggest in conclusion that the use of current at 2,000 volts pressure does not seem to have very clear indications, and may not be a true requirement in these small animals. Considerably increased direct cost is thereby incurred, and special precautions in respect of insulation (with the concomitant risk of breakdown) are necessitated. This voltage-level would appear to have been adopted in imitation of the practice in man. But it is the provision of a proper current-volume that is the sole issue at stake, and the voltage-rating as such is no guarantee of this. Indeed without good regulation a high voltage may well be inferior. On the other hand, the passage of excessively heavy current has itself certain contra-indications (Ferris *et al.* (1936)). Compromise with due regard to the several factors involved is called for, and it would seem improbable in the light of these that voltage anything in excess of 500 is necessary in the case of the dog and cat (provided always that the heads of the animals are in circuit.)

Electricity in Clinical Anaesthesia.—The possibilities of electricity as an anaesthetic in clinical work are implied in the review of the literature. It is in the sphere of agricultural veterinary activities that the subject seems to the writer to hold such remarkable promise, though it is impossible to ignore that a true electro-narcosis might prove to be the method of anaesthesia of the future, in man and animals alike.

The late Sir Frederick Hobday immediately foresaw the possibilities of the technique of simple stunning in general veterinary practice, and gave the ordinary "electro-lethal" trial for the induction of general anaesthesia for castration and herniotomy, with results that were on the whole satisfactory (1932, 1935), although his procedure was essentially of the crudest. These, however, are the only essays of the kind on record.

Major surgical operations under the Leduc current have been performed on animals. Robinovitch (1914) mentions the use of this current for laboratory surgery, and Frostig *et al.* (1944) refer to its similar usage by Tuffier and Jardrey (1907). Hertz (1933) performed operations on dogs in the course of his in-

* It may be of interest to refer for comparison to the technique of penal execution as practised in America, for there is no doubt that the official use of electricity as a means of execution in man carries for the public an implication that electrocution must therefore be essentially humane. This concept has as much foundation, in fact, as the equally general one that the term "lethal chamber" in some way connotes euthanasia. It is, of course, the precise manner in which these measures are employed that determines their humane propriety or otherwise.

The current is passed from a skull-cap through the head and trunk to the leg. The voltage applied is of the order of 2,000, and owing to the excellence of the electrode-contacts the resistance of the subject may be as low as 200 ohms. Thus current of the order of 10 amperes is involved (and a power of some 20 kilowatts). These conditions are maintained for 3 seconds, when the voltage is dropped to 500 for 57 seconds, the rationale of this being that it provides for a current of some 2-3 amperes, the presumptive optimum for the induction of fibrillation in man. The voltage is then restored to the 2,000 level and the cycle repeated. It is then again raised to the same level before switching off. At the conclusion of the operation the rectal temperature is stated to have risen to even 140 F., and the intra-cranial temperature approaches boiling-point.

These somewhat gruesome details are given because they indicate a technical ideal, and provide at the same time excellent contrast with the accepted practice in the case of animals. By inclusion of the head in circuit, instantaneous loss of consciousness is guaranteed. The optimum conditions for fibrillation are then provided.

vestigations, including a laparotomy. And it is here that it becomes necessary once again to emphasize the potential menace of the employment of electricity in animals without a complete knowledge of the requirements. For it is the unpleasant fact that in the same paper as Hertz records his surgery on dogs, he reports that his human subjects, undergoing similar electric treatment, were fully pain-conscious. It is universally certain that any general adoption of electric measures must be contingent on the availability of incontrovertible data as to the conditions under which they will and will not provide anaesthesia.

An interesting development in clinical neuro-surgery has recently come to notice. Freeman (1948) in introducing a new technique for prefrontal leucotomy in man, has also introduced electric shock as the anaesthetic of his choice for the operation. The patient receives current at 150 volts pressure across the head for 1 second. This results in a convulsion followed by surgical anaesthesia usually of several minutes duration, and ordinarily sufficient for the surgical interference. The treatment is applied at each of the two stages of operation.

The topical interest of this is great, for it will be noticed that the voltage applied is more than double that considered adequate for anaesthesia in the pig. Yet the writer has personally witnessed an operation on one patient of unusually low susceptibility to the current, in whom partial recovery of consciousness was manifested 90 seconds after the first shock, necessitating a second application. This provides evidence, as incontrovertible as it is gratuitous, of the validity of the arguments developed against present-day abattoir practice.

In corollary, there seems good reason to hope that improved electro-technology (perhaps with the invocation of principles not yet represented in the literature) may lead to the emergence of methods of electric anaesthesia of genuine practicability. These could have numerous and outstanding advantages over the existing chemical methods, such as induction with unexampled speed and facility, and comparably rapid reversibility. Not the least appeal of the whole conception lies in what, for want of a better term, may be styled the "physiological compatibility" of electricity, electric current being of course as integral and normal a component of the tissues in general and of the nervous system in particular, as oxygen is of the blood. Thus a complete absence of toxicity, and of the side-effects and after-effects of the chemical anaesthetics, might be realizable, and indeed seems already to have representation in the literature. A particular advantage of this would be the consequent extension of the method into laboratories where at present, for various reasons, the animal subjects may be denied the benefit of anaesthesia.

The phenomenon of amnesia, particularly of retrograde amnesia, must also be recognized as having great potential value in unusually temperamental animals, which may suffer permanent relative disability in consequence of even one unfortunate experience. The sum total of advantage and benefit accruing in at least the veterinary sphere, from the availability of methods of anaesthesia such as are envisaged, defies assessment.

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FORECASTING THE INCIDENCE OF NEUROSIS IN OFFICERS OF THE ARMY AND THE NAVY.

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I. THE NEED FOR A SYSTEMATIC METHOD OF INTERPRETING CLINICAL DATA.

THE most important contribution the psychiatrist could make to the selection of officer candidates or of applicants for comparable leading or managerial positions would be the exclusion of potential neurotics. The Report on the Work of Psychologists and Psychiatrists in the services acknowledges and commends the contribution made by psychiatrists to the selection of officers in the Army; but evidence has not yet been published to enable the extent of their particular contribution to the efficiency of the whole procedure to be assessed in measured terms. Other services have not followed the example of the Army. The Admiralty and Civil Service Selection Boards, which were created after the War Office Selection Boards, and have adapted many features of the Army procedure for their own requirements, have decided against employing psychiatrists for this purpose; and the extent to which the War Office Selection Boards make use of psychiatric services for selection has been reduced. The effectiveness of existing psychiatric methods for this kind of work may thus be felt still open to some doubt.

Every psychiatrist who has tried his hand in preventive and social work knows the difficulty of predicting neurotic breakdown in a person. A number of "pointers" taken from the history and of observations during the interview are generally used for this purpose. "Pointers" are any items of information which can be readily obtained, and which can be shown to be relevant although not decisive as differentiae of persons in whom neurotic states are found to occur. Their evaluation and the interpretation of their cumulative significance is decided mainly on personal impressions and clinical acumen.

In our opinion, too much is left to the intuitive sagacity and clinical discrimination of the examiner. Even the smallest step towards standardization of clinical data seems worth while. An objective method of evaluating the significance of the clinical findings is especially needed, if the clinical examination is only a part of a more comprehensive selection procedure, and a final decision on the merits of any particular candidate has to be reached by combining the findings of the clinician with the data obtained by other

observers using different techniques in their parts of the same procedure. Moreover, different clinicians working in the same field are unlikely to return consistent results unless they are provided with methods which are objective and have been standardized; and their training for their work is less likely to be reliable. Finally, even if standardization does not lead to an immediate improvement, it provides a starting-point for systematic experimentation to assess what advantages can be gained by modified methods.

The present investigation is an attempt to find a method of this kind by making use of material examined in a Military and a Naval Hospital, and comparing it with material obtained from a normal control group.

2. COLLECTION OF THE INFORMATION.

On the basis of general psychiatric experience a number of pointers was selected which should be easily accessible in an interview and obtained with a minimum of subjective bias. By going over the case histories of 30 unselected neurotics admitted consecutively to the Military Hospital, the most frequent and significant pointers were noted. We thus arrived at the 16 pointers used in the primary analysis (described in the following section as numbers 1 to 16). The personal element was partially checked by taking the data from two observers working independently (Groups A and B); the 16 pointers were not known to either of the observers when they carried out their psychiatric interviews, but were deduced afterwards from their case-notes. After the initial interview the patients had been treated and observed by the psychiatrist in hospital. Information on the patients was also available from their superior officers, regimental medical officers and relatives. However, most of the indicators were assessed in the interview from the patient himself. The advantage of corroborative information and observation will be rarely given in a selection procedure; but at the outset, the broadest possible basis of reliable information seemed desirable on which to build a foolproof system of questions suitable for short application.

After establishing the frequency of the indicators in 100 neurotic Army Officers, we were—through the courtesy of the Admiralty—able to peruse 101 bed tickets of officers of the Navy treated for neurosis in a Naval Hospital. These officers had undergone full investigation and study similar to that of the Army cases. All but a few had been examined by one psychiatrist. The incidence of the 16 pointers was noted in each patient.

Control data were obtained from 55 officers of a mobile Division billeted in the district. They were invited to volunteer by a circular letter of the Divisional Medical Officer pointing out in general terms the idea of the investigation. The response was almost universal, the co-operation very satisfactory, and the number of subjects was only limited by the departure of the Division from the district. Each officer was interviewed for approximately half an hour, during which time the incidence of the 16 pointers could be ascertained without difficulty. All officers had seen successful service in the Army for an average of more than three years under conditions very similar to those under which the neurotic reactions of our patients occurred.

The suitability of this series as controls can be criticized on two points. The subjects may not be unselected, because officers with features generally regarded as abnormal may not have volunteered for the inquiry for fear of being found out. No indication of a biased selection of this kind was revealed during the interviews. Judging from reactions to public inquiries one would even expect the abnormal to come forward with greater eagerness on such an occasion than the average man. One can assume that the two tendencies have balanced themselves out in the group. Furthermore, the interview of the controls was so much shorter and less thorough than the examination and observation of the neurotics that pointers may have been missed by the psychiatrist. There is no answer to this criticism but the experience and competence of the examining psychiatrist, and the fact that the officers were members of a contingent under arduous training preparing to take part in the most important and decisive operation of the war.

3. DIAGNOSIS OF THE CASES ; NOTES ON THEIR HISTORY AND DISPOSAL.

(a) *Diagnosis.*

Table I gives the frequencies of the diagnoses of the neurotic cases.

TABLE I.

Diagnosis.	Army.	Navy.	Total.
Anxiety state	53	61	114
Hysteria	20	13	33
Psychopathic personality	15	17	32
Obsessional state	11	6	17
Post-traumatic personality change	1	4	5
	100	101	201

The proportions of numbers in the different groups is more likely to be typical of officers in the two services than of the entire strength including other ranks, and still less likely to be typical of the general population. The selected nature of the sample is particularly shown by the high proportion of obsessional states.

The Military Hospital had separate wings for psychotic and psychoneurotic cases, hence it has been possible to differentiate the frank psychoses from the neuroses more thoroughly than is sometimes possible in a hospital which officially only accepts neuroses. Despite this advantage, out of 53 anxiety states 18 showed depressive features, which none the less did not disqualify them, in our opinion, from inclusion in this series.

A similar sprinkling with cyclothymic symptoms was present among the Navy cases. This was to be expected in view of the higher incidence of affective psychoses and constitution among the educated classes of the population (E. Slater, 1937).

(b) *Type of Commission.*

Forty Army Officers and 45 Naval Officers came through the ranks, but 60 and 55 respectively had received direct commissions. Eleven Army Officers had regular commissions, the corresponding figure for the Naval Officers being unknown. Six Army Officers had passed through Sandhurst, 5 Naval Officers through Dartmouth.

(c) *Age Composition.*

Table II shows the ranges of ages among the groups.

TABLE II.

		Army.	Navy.	Controls.
20-25		17	34	18
26-30		23	22	20
31-35		23	20	15
36-40		15	11	2
41-45		16	11	—
46-50		6	2	—
		100	100	55

NOTE.—No age recorded for one Naval Officer.

Unfortunately both the Navy patients and the controls represent a younger age-group than the Army patients. As, however, the majority of our pointers should have become manifest at the age of 25, this difference was unimportant. Statistical analysis (see later) has shown that there is no significant association between the number of pointers and age.

(d) *Length of Service in World War II.*

There was also no correlation between length of service and number of pointers. Among the Army patients length of service varied from 3 months to 3½ years, with an average length of 26 months. These patients were seen in 1941 and 1942. Length of service of the Naval officer neurotics, many of whom were seen in the later part of the war, varied from 3 months to 5½ years, with an average of 36 months. In the control group length of service varied from 5 months to 5 years, with an average of 45 months.

Service as a regular before the war and in the Territorials is not included in these figures. It has also to be remembered that many of the officer patients had spent considerable periods in hospital and in transportation from overseas before being seen by the psychiatrist. Hence the length of service figure does not necessarily imply that they had rendered useful service for this period.

Twelve Army officers, but only 3 Navy officers, had held a commission in World War I.

(e) *Exposure to Actual Warfare or Bombing.*

Army and Navy cases differed considerably in this respect. In the 32 Army patients who had taken part in fighting or bombing, the exposure varied from Dunkirk, Dieppe, Libya, blitzes, to the bombing of an Ack-Ack gun-site. Very few were admitted immediately after enemy action; as a rule there was a long time interval between exposure and admission.

The majority of the Naval patients, namely 74 cases who reported exposure, date their neurotic reaction, probably correctly, from this event. All the hazards of warfare at sea figured among the experiences quoted; but again in many cases much time had elapsed before the patient came under the care of the specialist.

(f) *Disposal.*

Of the Army Officers, only 39 were retained in the Service, while 61 were discharged. In the Navy neurotics this ratio was reversed—74 retained against 26 discharged. The difference may be due to the different age composition, or to the different attitudes of the two Services towards neurotics. The most probable explanation is that the Army patients suffered from a more severe, constitutional type of neurosis, while among the Navy patients were a number of neurotic reactions to the stress of warfare.

4. DEFINITION OF THE POINTERS.

The pointers are presented in the order usually adopted in taking a case history. In fact, they have been and should be ascertained during taking a life history in a routine psychiatric interview. This gives the observer an opportunity to evaluate the importance of the pointers against the background of the subject's development and adaptation. Evaluation is necessary in a number of pointers (2, 3, 11, 13 and others) before deciding if it should be counted in the special case. It is because of this evaluation that only the experienced psychiatrist will be able to use the list of pointers with similar results.

1. *Heredity.*

This was narrowly interpreted, only taking into account parents and siblings. Besides psychoses, there were also included any marked neurotic illness or symptoms such as obsessions, phobias, gross hysterical behaviour and hypochondriasis.

2. *Physical Ill-health.*

This pointer was considered present when physical ill-health occurring in childhood or later was persistent enough to have a probable effect on the patient's development and adjustment, e.g. cardiac invalidism, osteomyelitis preventing a boy from playing games at school, asthma, chronic chest complaints, gastro-intestinal complaints, etc.

3. *Neurotic Traits in Childhood.*

Faddiness about food, phobias of water, heights or animals, tantrums, tics, nail-biting, bed-wetting, night terrors, sleep walking and other sleep anomalies. More than one of these traits had usually to be present, and they were evaluated according to duration and intensity.

4. *Former Psychiatric Illnesses.*

Neurotic and psychotic episodes, "breakdowns," acute and chronic; amnesias for a period, fugues, fits; also long spells of unemployment ascribed to exhaustion, neurasthenia or inertia.

5. *Unintelligent, Backward, Defective.*

The candidate's response to the interview and his life story often raised the suspicion of low intelligence.

No special tests were used, but the usual clinical method of setting simple arithmetical problems (money divisions, 100 minus 7, etc.) and general knowledge questions was applied in all cases.

6. *Shy, Solitary, Markedly Introverted in Childhood or Adolescence.*

This pointer was only taken into account when introversion and shyness extended over a considerable period, and was not merely a phase of juvenile sensitiveness. Like the next pointer (7), it was sometimes disclosed on direct questioning, but more often during the taking of the life history.

From the Army Officers' case histories it seemed worth while to draw a distinction between pointers 6 and 7, because one-quarter of these cases appeared to have overcome the adolescent shyness when they reached adult life.

7. *Difficulty in Making Social Contact: "The Bad Mixer."*

This is often shown by inability "to hit it off" with colleagues and by dislike of club or mess life. It is easily elicited by discussing early life, hobbies (some of which are asocial), and school record. For the officer who is a bad mixer, service life is a severe strain. Several very competent officers in our series have attributed their breakdown to the necessity for repeated adaptations to new colleagues. Poor "rapport" during the psychiatric interview may or may not disclose the "poor mixer"; it may be a transient reaction to the special situation.

8. *Emotional and Temperamental Instability.*

Moodiness and bursts of temper; depressive spells in some cases approaching cyclothymic alternations; other uncontrolled emotional reactions; emotional immaturity as shown in irrational decisions in vital questions such as marriage, choice of occupation, etc.; extravagant ambitions leading to frustration.

These various features have been grouped together because it was difficult to separate them in practice. The broad grouping may partially account for the high figures given in Table III below.

TABLE III.—Incidence of Each Pointer in Each Group of Men.

Number of cases :		(Groups.)										Control group.	Nature of pointer.
		Neurotic groups.			Army personnel.								
		Naval personnel.		Total.	Group A.		Group B.		Total.	All neurotics.			
		Retained.	Discharged.		63.	37.	100.						
		74	27	101	Proportion with the pointer positive.					201	53		
Pointer	1	.30	.56	.37	.41	.54	.46	.41	.41	.13	Heredity.		
"	2	.23	.26	.24	.35	.22	.30	.27	.27	.09	Physical ill-health.		
"	3	.12	.48	.37	.56	.51	.54	.45	.45	.16	Neurotic traits in childhood.		
"	4	.22	.48	.29	.41	.51	.45	.37	.37	.05	Former psychiatric illnesses.		
"	5	.07	.07	.07	.10	.08	.09	.08	.08	.00	Defective intelligence.		
"	6	.27	.26	.27	.43	.70	.53	.40	.40	.11	Adolescent shyness.		
"	7	.19	.44	.26	.35	.49	.40	.33	.33	.07	Adult shyness.		
"	8	.70	.70	.70	.76	.73	.75	.73	.73	.09	Instability.		
"	9	.31	.44	.35	.41	.35	.41	.37	.37	.13	Obsessional traits.		
"	10	.53	.59	.54	.70	.51	.68	.59	.59	.02	Apprehensiveness.		
"	11	.45	.59	.49	.52	.68	.58	.53	.53	.04	Dependence in childhood.		
"	12	.22	.07	.18	.32	.24	.29	.23	.23	.07	Unstable work record.		
"	13	.28	.33	.30	.40	.35	.38	.34	.34	.05	Sexual difficulties.		
"	14	.14	.22	.16	.29	.22	.26	.21	.21	.00	Alcoholism.		
"	15	.18	.11	.16	.10	.08	.09	.12	.12	.09	Head injury.		
"	16	.03	.00	.02	.05	.05	.03	.03	.03	.00	Accident proneness.		
"	17	.04	.04	.01	.16	.22	.18	.11	.11	.00	Service in former war.		
"	18	.03	.04	.03	.11	.00	.07	.05	.05	.00	Commission in former war.		
"	19	.00	.00	.00	.05	.08	.06	.03	.03	.00	Neurotic illness in former war.		
"	20	.78	.56	.72	.33	.27	.32	.32	.32	.56	Exposure.		

9. *Obsessional Features.*

These were only recorded if severe and of long standing. Episodes of belief in magic rituals and other superstitions during childhood were not considered as obsessional features, nor were orderliness, punctuality and accuracy in personal or business matters as long as they did not interfere with the ordinary life and occupation of the subject.

10. *Apprehensiveness.*

Stage fright, anticipatory anxiety, inadequate self-confidence. Common symptoms were vasomotor instability, precipitancy of micturition, stress diarrhoea on the eve of critical moments. Some of these patients had spent considerable periods in general hospitals; the psychological nature of their symptoms was not always realized. If concealed during the taking of the history the symptoms may manifest themselves during practical tests.

11. *Dependence in Childhood and in Later Life.*

Dependence on parents or other relatives, on special friends, on the home or the wife, not only in critical situations, but also in the ordinary course of life. Inability to attend to regular work outside the family sphere; marked attachment of the grown-up son to his mother; people constantly in need of props in the form of advice from their elders or from their marriage partner. Dependence on certain localities, or on a special type of collaborator, etc.

12. *Unstable Work Record.*

The work record was not considered unstable only because more than a certain number of changes took place in a certain time. These changes may have been necessary to acquire full professional experience or, in another case, may be the result of unfavourable circumstances beyond the subject's influence. On the other hand, apparent stability may be due to a comfortable job in the family business; in that case only school and academic records may reveal the tendency to instability.

Unstable work record was considered present if the changes of employment were frequent and poorly accounted for, or if a new kind of occupation was started on several occasions.

13. *Marriage and other Sexual Difficulties.*

The difficulties have been weighed against the special circumstances of the case; but the pointer was considered present if there was a history of divorce or separation, if the marriage was disturbed through alleged or real infidelity, or extreme jealousy. Also, if there was any kind of sexual aberration.

14. *Alcoholism.*

This was defined as transient or regular over-indulgence in alcohol interfering with professional efficiency, family relations or home life of the subject.

The difficulty of obtaining reliable data from officers has been considerable, and the acumen of the observer with psychiatric schooling was especially needed to ascertain this pointer.

15. *Head Injury.*

Any history of head injury followed by loss of consciousness, however short, was recorded as positive.

16. *Accident Proneness.*

A sequence of more than two accidents was considered as accident proneness.

Besides these 16 pointers, the following four facts from the patients' histories were recorded :

17. Service in World War I.

18. Commission in World War I.

19. Neurotic illness in World War I.

20. Exposure to actual warfare and bombing in World War II.

5. DISCRIMINATORY VALUE OF THE SEPARATE POINTERS.

Table III shows what proportion of the cases in each group exhibited each pointer. For instance, it shows that evidence of hereditary predisposition was found among 41 per cent. of the neurotics but only among 13 per cent. of the control cases ; among 37 per cent. of the neurotic officers in the Navy and 46 per cent of those in the Army ; and gives separate rates for sub-groups of Army and Naval personnel. Table IV shows which of these rates differ significantly from one another. For instance, it shows that the incidence of hereditary predisposition is significantly higher among neurotics than among normals, and indicates, therefore, that it is a useful pointer. It shows that in this respect neurotic officers in the Navy do not differ significantly from those in the Army ; that the rates found in groups A and B of the Army Officers are approximately the same ; but that the rate amongst the retained Naval personnel is significantly lower than amongst the discharged. For convenience, values of χ^2 which are too small to be significant are simply indicated by a dash.

The values in the right-hand column of Table IV can be used to rank the pointers in order of discriminatory value. It may be because of the wideness of the range of symptoms which it includes that emotional and temperamental instability (8) has so high a discriminatory value ; but, as the analysis in section 7 shows, it belongs, together with former psychiatric illness and alcoholism, in a sub-class of pointers which are distinguishable from the remainder and merit special consideration. Emotional equipoise and stability thus appear to be of paramount importance as a protection against neurotic break-down, and improvements in their assessment are particularly likely to be rewarding.

Apprehensiveness (10) comes next, and dependence (11) after it in rank. The importance of dependence has been noted by other observers (Sutherland,

TABLE IV.—*Comparisons between the Rates of Incidence in Different Groups and Sub-groups.*

Pointer.	Values of χ^2 for comparing—			
	Sub-groups of—		Army and Navy.	Neurotics and controls.
	Naval personnel.	Army personnel.		
1	4.6	—	—	14.2
2	—	—	—	17.1
3	—	—	5.4	14.0
4	5.6	—	5.1	18.7
5	—	—	—	—
6	—	6.0	13.4	14.9
7	5.5	—	4.0	12.9
8	—	—	—	69.5
9	—	—	—	10.5
10	—	—	—	53.9
11	—	—	—	41.4
12	—	—	—	6.1
13	—	—	—	16.0
14	—	—	—	12.3
15	—	—	—	—
16	—	—	—	—
17	—	—	—	5.3
18	—	—	—	—
19	—	—	—	—
20	—	—	31.1	—

NOTE.—Every value of χ^2 shown has 1 degree of freedom. Yates's correction has been used throughout. Values of χ^2 with probabilities exceeding .05 have been omitted.

1941). It is frequently associated with ambivalence in feeling and judgment. The clinical impression is that infantile dependence is a conspicuous indicator of low morale, especially when associated with self-regard and other narcissistic traits.

Although an unstable work record (12) may be prognostically unfavourable among men in the ranks, with regard to officers its value as a pointer is deceptive. Especially if they come from well-to-do families, officers may have previously led comparatively sheltered lives and have unblemished work records, and yet may break down under the greater stress of army life. Judged by Table IV, this pointer is the least valuable of those retained for analysis in section 8.

While lack of intelligence (5) can no doubt be shown, on other evidence, to be unfavourable to success as an officer, our evidence shows that among this group of men it does not establish a predisposition towards neurosis. A useful review of the general evidence on this subject is given by Eysenck (1947). Much of it is conflicting. His own evidence shows slightly less

intelligence among neurotic service patients admitted to Mill Hill Emergency Hospital than among men tested before military training; although the difference is not great, it is confirmed by so many cases that its statistical significance is beyond question. Nevertheless, we doubt how far any general conclusion can be drawn. We would expect systematic comparisons to show differences of about the same order between cases admitted to different centres, and even between cases admitted to the same centre at different periods, in addition to the differences which can be shown to exist between diagnostic groups (Slater, P. (1945)). Army records show equally great differences between intakes in different regions, and between total intakes at different dates. Moreover, a sample representative of intakes would not be representative of the whole service, since scores decline with age. If deficiency in intelligence does establish any predisposition towards neurosis, we would infer that adequate precautions against this risk are taken at other stages in the procedure for selecting officers, and that the psychiatrist cannot make any effective contribution by applying methods of assessing intelligence of the kind described here.

As no experimental distinction was made between the A and B Army groups when the data were collected, except in obtaining them from two different observers, there is no reason to expect any pointer to exhibit a difference between them unless the observers have interpreted it differently. Pointer 6 is the only one to exhibit such a difference. The marked difference it also shows between the neurotic officers in the Army and the Navy is a further indication that its reliability is not above suspicion. In the final analysis it proves of negligible value. In connection with the remaining pointers this evidence is important: it shows that their definitions can be consistently interpreted. It also justifies combining the two groups, as has been done in some subsequent analyses, or re-sorting them into retained and discharged cases, as has been done in others. 43 of the retained cases come from Group A and 18 from B.

In order to establish the value of pointers 3, 4, 6 and 7, which do not occur amongst Navy cases with rates similar to their Army rates, their rates amongst normal men need to be proved significantly lower than either. This is demonstrated by the values of χ^2 given in Table V.

TABLE V.

Values of χ^2 for comparing the
control group with—

Pointer.	—	
	Navy cases (total).	Army cases (total).
3	6.1	19.3
4	10.4	24.1
6	4.4	24.9
7	6.7	17.1

NOTE.—Each value has one degree of freedom.

All these pointers are found more frequently among the Army cases. A psychiatric interview could have excluded a large proportion of the 45 Army

cases with former psychiatric illnesses. Six had had minor nervous disorders during the last war and some had pensions for them. Two passed out of Sandhurst, 13 came through the ranks (before selection came under the control of the Directorate of Selection of Personnel), and the remaining 30 had received direct commissions.

Pointers 1 to 4 and 6 to 14 are the ones which have been retained for the analyses which follow.

6. THE IMPORTANCE OF DIFFERENCES IN AGE AND LENGTH OF SERVICE.

As already mentioned, we were unable to match our neurotic cases with control cases which are exactly similar in other respects. The groups differ considerably in their average age and length of service, particulars of which are given in Table VI.

TABLE VI.

Group.	Number of cases.	Average age.	Average length of service.
Navy, retained	73*	28.88	2.75
„ discharged	27	34.48	3.52
Army, retained	61	33.41	2.43
„ discharged	39	33.85	1.90
Controls	55	27.69	3.70

* No age recorded in one case.

The total variance of age in years is 13276.12; and 14.5 per cent. (a highly significant part) of it is attributable to differences between the groups. The total variance of length of service in years is 325.41, and a still larger part, 30.4 per cent., is due to differences between the groups.

If the incidence of the pointers varied with age or length of service, the differences between the groups might raise problems leading to controversial interpretations of the data. We might have to consider the possibility that the occurrence of any symptom or combination of symptoms is dependent on age and/or length of service; or alternatively that the number of symptoms present in a man will determine the age he can hope to reach and, or the amount of service he can hope to perform before developing a neurosis. Fortunately, however, all such controversies can be excluded. The number of pointers (i.e. of the retained pointers) recorded for every officer was compared with his age and his length of service, to find whether there was any evidence that these variables are associated with one another within any of the groups. The correlation between age and number of pointers within groups was found to be -0.0555 , and that between length of service and number of pointers to be -0.0156 . Both of these correlations are less than the standard error of a zero correlation with the same number of degrees of freedom (250), which is ± 0.0632 ; neither is significant. Consequently age and length of service can

be left out of account when different officers or groups of officers are compared in terms of number of pointers per person.

7. PROBLEMS INVOLVED IN DETERMINING THE COMBINED WEIGHT OF THE POINTERS: THE SIMPLEST TREATMENT OF THE DATA.

Any proposal to estimate the probability that a man may become neurotic from a simple count of the number of pointers that he exhibits is likely to appear repugnant to clinical experience. The symptoms observed in a particular case are facets of a complete personality, and can be seen to be dynamically integrated. It may seem a gross misrepresentation to treat them as if they could be simply numerically summed. Thus one of our cases is that of a man of 23, who shows an excessive dependence on his mother, with marked ambivalent feelings towards her. This is combined with a history of tantrums and blackouts in childhood, and an attitude to life of extreme ambition and frustration. The pointers exhibited are 3, 8 and 11—a total of three. But is it merely a coincidence that these are the three that have occurred concomitantly in this case? Another case is of a man who is extremely jealous of his wife, and has been prone to moodiness and bursts of temper since youth. His father was obsessional. The pointers exhibited are 2, 8 and 13—another combination of three. In another case we have a history of asthma alternating with eczema. This man is unable to mix freely with other officers, and suffers from a phobia about his hair. The pointers are 1, 7 and 9—another combination of three. There seems to be no equivalence or similarity, other than an arbitrary mathematical one, between these three cases each with a score of three.

But it does not follow that a statistical approach to this problem is impossible, and that no attempt should be made to estimate the cumulative significance of combinations of pointers in precise terms. The clinician who undertakes to review all the evidence at his disposal in order to assess the risk of a neurosis occurring in a particular case, does in fact attempt to crystallise all his observations in a single judgment. In our opinion, it is not in a wholly metaphorical sense that this kind of judgment is usually described as weighing the evidence and summing it up. If the clinician prefers to do this in an intuitive way, without the aid of mathematical symbols, it is partly, we believe, because he is prepared to assign more weight to a particular piece of evidence in one case than in another. The objection is thus, not that the statistical approach is wholly inappropriate, but that it may prove crude and naive, over-simplifying the problems, estimating the value of evidence incorrectly and introducing unnecessary errors into final conclusions.

Allowances can be made for objections of this kind in a statistical approach by measuring the total amount of error variance and finding how far successively more complicated assumptions can reduce it. A straight count of the number of pointers exhibited by each individual involves the simplest possible assumption, namely, that each pointer should be assigned the same weight as every other, and that its weight should not vary from case to case. This provides the results shown in Table VII.

TABLE VII.

Total number of pointers per person.	Frequency of a given total number of pointers per person among neurotics.							Normals.	Total of neurotics and normals.
	In the Navy.			In the Army.			Both Forces Total.		
	Retained.	Discharged.	Total.	Group A.	Group B.	Total.			
0	1	2	3	1	—	1	4	26	30
1	11	—	11	2	1	3	14	17	31
2	9	3	12	—	1	1	13	8	21
3	9	1	10	11	6	17	27	2	29
4	5	3	12	7	6	13	25	—	25
5	17	4	21	8	3	11	32	1	33
6	5	4	9	5	3	8	17	—	17
7	6	1	7	10	4	14	21	1	22
8	6	7	13	9	5	14	27	—	27
9	—	1	1	4	4	8	9	—	9
10	1	1	2	5	3	8	10	—	10
11	—	—	—	1	—	1	1	—	1
12	—	—	—	—	1	1	1	—	1
Total	74	27	101	63	37	100	201	55	256

The average numbers of pointers per person in the various groups are :

Group.	Number of pointers per person.
Navy, retained	4.15
„ discharged	5.44
Total, naval neurotics	4.50
Army, Group A	5.90
„ „ B	6.05
Total, army neurotics	5.96
„ all neurotics	5.22
Normals	0.93

The difference between the normals and the neurotics is striking ; the differences among the neurotics are relatively small, though not altogether insignificant, as is shown in Table VIII, below.

The two Army groups can be divided and re-classified as follows :

Group.	Number of cases.	Average number of pointers per person.
Group A, retained	43	5.40
„ discharged	20	7.00
Group B, retained	18	5.22
„ discharged	19	6.84
Total retained	61	5.34
„ discharged	39	6.92

The total variance of number of pointers per person is 2277·84, and can be broken down in the proportions shown in Table VIII :

TABLE VIII.—*Analysis of the Variance of the Number of Pointers per Person.*

Source of variance.	Per cent. of total variance ascribable to the source shown.	Degrees of freedom.
1. Variance between normals and neurotics .	35·00	1
2. Between retained and discharged neurotics	5·17	1
3. Between the Navy and the Army groups of each kind of neurotic	3·63	2
4. Between the two Army groups of each kind	·03	2
5. Residual variance (error)	56·17	249
Total variance	100·00	255

Thus even this very crude and simple method of combining the results provides a useful measure of propensity to neurosis. 35 per cent. of its total variance is attributable to the difference between the neurotic officers and the normal. Discharged neurotics are shown to have a significantly higher average number of pointers than retained neurotics. In both groups the average number of pointers is significantly higher among the Army cases than in the Navy—we prefer not to make any selection from among the alternative explanations that might be offered for this phenomenon. But compared with the difference between neurotics and normals these differences among the various groups of neurotics are relatively small.

Finally the evidence shows that the averages of the A and B groups of Army cases do not differ significantly. This provides us with some justification for hoping that competent observers may be consistent with one another in deciding when to record a pointer as present or absent.

8. PROBLEMS INVOLVED IN DETERMINING THE COMBINED WEIGHT OF THE POINTERS: ADVANTAGES TO BE GAINED BY CLASSIFYING THE POINTERS.

This rough and ready treatment of the data does not allow for differences between the pointers. We need to consider the questions: Do any characteristic combinations occur among the pointers? and, if so, can any advantages be gained by making allowances for them?

If certain pointers or items are particularly likely to occur in special syndromes or characteristic combinations, it should be possible to divide them into classes corresponding to the combinations: for an item to belong to class A, it should be more likely to occur concomitantly with the remaining items in class A than with the items belonging in any other class. But if no special syndromes occur, no separate classes of particularly closely associated

The first pointer was recorded in 90 of the 256 cases, the second in 54. 18.98 cases (i.e. $90 \times 54 \div 256$) could be expected to exhibit both if the two are independent, i.e. if each is no more likely to occur when the other is present than when it is absent. Actually the two occur concomitantly in 24 cases—5.02 more cases than expected on the assumption of independence. This figure forms the first entry in Table IX. The remaining entries are the corresponding figures for other pairs of pointers.

Table IX resembles very closely and could be converted into a matrix of correlations to which a factor analysis of the usual kind could be applied. But it has been analysed directly without any such transformation. This treatment rests on a simpler set of assumptions, and leads more directly to an appropriate test of significance.

If there are no special syndromes, each pointer should have a single general probability of occurring concomitantly with every other. If we denote item I 's probability as p'_i and item J 's as p'_j , then in a sample of n cases we must expect items I and J to occur concomitantly $np'_i p'_j$ more times than they would if they were independent. For each item we should be able to find a single value of p' such that, whatever the items we refer to as I and J , $np'_i p'_j$ will not differ significantly from its corresponding entry in Table IX. This proves impossible. The assumption that there are no special syndromes, i.e. that all the items belong to a single general class and that no sub-classes need to be differentiated, fails to account for the exceptionally close associations between pointers 6 and 7 and between pointers 8 and 14; it also provides an inadequate account of the associations between pointer 4 and other pointers, and gives a generally bad fit.

A satisfactory fit is provided by the values given in Table X.

TABLE X.—*Values of $p'_i \sqrt{n}$ for Estimating the Frequency of Concomitance of Pointers in the Same Class and Sub-class.*

Pointer.	Main class.	First sub-class.	Second sub-class.
1. Heredity	2.13	—	—
2. Physical ill-health	2.11	—	—
3. Neurotic traits in childhood	4.62	—	—
4. Former psychiatric illnesses	3.45	1.24	—
6. Adolescent shyness	3.96	—	3.81
7. Adult shyness	3.28	—	3.81
8. Instability	4.42	1.88	—
9. Obsessional traits	1.74	—	—
10. Apprehensiveness	5.25	—	—
11. Dependence in childhood	4.61	—	—
12. Unstable work record	2.00	—	—
13. Sexual difficulties	2.81	—	—
14. Alcoholism	0.57	5.14	—

These values correspond to the factor loadings in a factor analysis of the usual kind. For instance, for pointers 1 and 8 the estimated frequency

of concomitance (in excess of the amount expected on the assumption of independence) is

$$2.13 \times 4.42 = 9.41,$$

since these pointers belong in the same main class but not in the same sub-class; while for pointers 4 and 8 it is

$$3.45 \times 4.42 + 1.24 \times 1.88 = 17.58,$$

since these pointers are also in the same sub-class. These estimates do not differ significantly from the observed frequencies, of 14.91 and 17.58 respectively, shown in Table IX.

Thus all the pointers fall into one main class, of pointers differentiating neurotics from normals; but within this general class there are two separate sub-classes, the first including pointers 4, 8 and 14, and the second pointers 6 and 7. The specially close associations between the items in these two sub-classes need separate explanation.

If neurotic break-down commonly occurs as a reaction to emotional stresses caused by trying situations, we may expect two broad types of people to be particularly prone to succumb: those who suffer from inadequacies of a permanent kind, and those who, though not so permanently handicapped, are liable to mood swings, depressive phases and other temporary conditions of reduced resistance to stress. Pointer 4, former psychiatric illness, 8, emotional and temperamental instability, and 14, alcoholism, indicate constitutional weaknesses of the latter kind. This may account for the fact that they are found particularly commonly in combination with one another, and form what might be described as a special syndrome. Pointer 12, unstable work record, is one which might perhaps be linked with this group, both on psychiatric grounds and on the statistical evidence contained in Table IX; but its general value as a pointer proves relatively slight in this inquiry (*cf.* section 5, above), and it cannot be assigned with certainty to this sub-class.

That pointers 6 and 7 occur exceptionally frequently in combination is not surprising, in view of the description given of them in section 3; they are manifestations of the same characteristic at different periods of life. Thus, although they appear as a special syndrome in the statistical analysis, there are no psychiatric grounds for expecting them to be specially significant for diagnostic purposes.

Since the values of the type $p'_i/\sqrt{n}$ in Table VIII provide a satisfactory fit to the frequencies in Table IX, any theory that there are other special syndromes among the symptoms is not supported by sufficient evidence in this investigation. It is surprising, in fact, how little evidence there is here for the existence of special syndromes. Perhaps this is partly because the pointers were not selected on purpose to test hypotheses of this kind; but the observer faced with the evidence, conspicuous in individual instances, of dynamic interconnections between characteristics of this kind is not likely to be completely satisfied with this explanation. There are two further explanations which may be worth consideration. Firstly, an individual endowed, by the

accidental concurrence of a fairly large number of rather peculiar events which is generalized as chance, with certain weaknesses of character, is bound in the course of his development to integrate them in the structure of his personality ; and in the mature personality they will thus appear functionally interconnected. Secondly, the number of ways in which similar weaknesses may be integrated into an organized personality may also be large, with the result that when observations on a large number of cases are collected and summarized, no consistent pattern of interconnections appears.

The fact that a general factor appears in the statistical analysis does not, in our opinion, constitute a proof that all the pointers are manifestations of a single underlying psychological trait. This phenomenon can be explained more simply. The pointers are observations found more frequently among neurotics than normals, and the sample consists of a mixture of cases of both kinds. The cases in which pointer 1 is found are probably the neurotic ones, i.e. the ones among which pointer 2 is likely to be found, etc. Therefore, the selection of the items, combined with the selection of the cases, must produce the appearance of a general factor automatically, provided only that the separate pointers are not each specific to a different type of neurosis. The phenomenon is thus adequately described by the statement that the symptoms do not tend to occur either in isolation or in strictly segregated clusters, but tend to overlap with one another almost indiscriminately, in the way we have just discussed.

This analysis justifies separating the pointers into three classes :

- A. Numbers 1 to 3 and 9 to 12 (i.e. those not included in either sub-class),
- B. Numbers 4, 8 and 14 (the first sub-class),
- C. Numbers 6 and 7 (the second),

to form, as it were, three short tests of tendency to neurosis. Instead of making a straight count of the total number of pointers of all kinds exhibited by each individual, we may count the number he exhibits of each kind separately, and thus obtain three scores for each individual. Or more refined procedures for calculating factor scores might be applied.

The advantages to be gained by this treatment of the data will be discussed in the second part of this paper. In a preliminary analysis, discriminant functions (Fisher) were calculated to find the most appropriate weight to assign to a score of each kind in order to obtain from their weighted sum the best possible estimate of an individual's probability of becoming neurotic. The weights thus found are in the proportions

- A. 1.0000
- B. 1.4850
- C. - 0.0585

They should not be treated as absolute measures of the value of pointers of the three kinds. Each measures the value of the pointers of one kind when used, as here, in conjunction with those of the other kinds. But it is clear, from their relative sizes, that if some of the pointers are to be discarded as

unnecessary, pointers 6 and 7 should be the first to go; and that if some additional pointers are to be introduced, those of the B kind (indicators of instability) are most likely to prove valuable. 45 per cent. of the variance of the weighted sums was found to be due to the difference between neurotics and normals. This can be compared with the 35 per cent. attributed to the same difference, as shown in Table VIII, when no distinction is made between the pointers and each is assigned an equal weight. The comparison indicates the advantage to be gained by classifying the pointers, and giving different weights to those in different classes.

A further extension of this method of analysis might be employed to find what weights are appropriate, when each pointer is allowed a separate weight to express its contribution to the best possible estimate of the risk of neurotic breakdown. By allowing each pointer its own appropriate weight, the efficiency of discrimination is bound to be increased to some extent: but how far cannot be estimated without a more elaborate analysis.

It is even more interesting to consider what advantages are to be gained by taking account of the differences in the incidence of the pointers among the neurotic cases assigned to different diagnostic groups. This will be discussed in the paper to follow.

Our main purpose here has been to submit an argument in favour of using clinical material of the kind available to psychiatrists in a similar manner to psychological test material, in order to provide a scale, or possibly more than one scale, for assessing the risk of a neurosis occurring in an individual case. We have explained some of the methods which can be used for evaluating the usefulness of particular pointers and groups of pointers for this purpose, and have found indications of the areas of observation in which additional useful evidence is most likely to be discovered.

SUMMARY.

When faced with the problem of judging the propensity of a person to neurosis, psychiatrists are accustomed to inquire for certain "pointers" taken from the history and observed during the interview of the person. The present paper is an attempt to systematize the use of such pointers, and to evaluate their significance for the selection of officer candidates and of applicants for comparable leading and managerial positions.

The 16 pointers used have been collected from the case histories of 100 neurotic Army Officers in a Military Hospital, and their frequency was ascertained in the bed tickets of 101 officers of the Navy treated for neurosis in a Navy Hospital. 55 Army Officers of a mobile division served as controls. Data were available on diagnosis, age, type of commission, length of service, exposure to warfare and disposal. A definition of the 16 pointers is given.

Using the sub-groups of Army and Navy, retained and discharged officers and those interviewed by different observers, the reliability of the single pointers and their discriminatory value was established.

No correlation was found between number of pointers and age or length of service—facts which, therefore, were without importance for the analysis.

In order to determine the combined weight of the pointers they were first simply counted. The number of pointers varied in the sub-groups of neurotics between 4.15 and 6.05, compared with 0.39 in the control group. By measuring the error of variance, this relatively crude method revealed certain interesting differences between the sub-groups, which, however, were small in comparison with the difference between neurotics and normals.

Characteristic combinations of pointers were studied using a specially adapted method of factor analysis. This led to the division of the pointers into three classes; a main class, which could be considered indicative of inadequacy: a second class, indicative of instability, which is apparently of considerable diagnostic value, although it only includes a small number of pointers; and a third class, probably of no independent diagnostic value, indicative of shyness. Counting the number of pointers in each class separately provides three tests of tendency to neurosis; and the preliminary evidence suggests that using the pointers in this way gives better results than combining them all in one straight count.

The analysis illustrates some of the possibilities of treating propensity to neurosis as a variable quantity, and designing one or more scales for measuring it. Further possibilities will be illustrated in a paper to follow on the same data.

We wish to express our gratitude to the Board of Directors of the Crichton Royal for monetary support of this study; to Dr. P. K. McCowan, Physician Superintendent, formerly Commanding Officer of the Military Hospital, Dumfries, for his permission to make use of the material of this hospital; to Surg.-Captain Desmond Curran, F.R.C.P., R.N.V.R., and to Surg.-Commander F. A. Hampton, M.C., R.N.V.R., for providing the material of the Navy Hospital. Our special thanks are due to the 55 officers who volunteered for being interviewed as controls.

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LEUCOTOMY IN THE PERIODIC PSYCHOSES.

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PERIODICITY as a phenomenon in nature has been known and studied from time immemorial. Astronomy and other sciences have built up a large body of knowledge which goes a long way towards explaining periodicity in the spheres with which they concern themselves. As it appears in the animal kingdom, however, the mechanisms underlying the phenomenon are still largely unrevealed. Of late years the hypothesis has been advanced that many of the periodic happenings in the human economy are subserved by the hypothalamus. Thus menstrual periodicity is held to be due to the hypothalamus acting in conjunction with the endocrine system. This paper is a small contribution to this hypothesis, maintaining as it does that the periodicity observed in certain psychoses is due to the influence of the hypothalamus on the prefrontal cortex. So far no similar report has been made in the large literature dealing with leucotomy and it therefore seemed worth while to give our results in some detail.

MATERIAL USED IN PRESENT INVESTIGATION.

The clinical material used in the present investigation consisted of 12 patients suffering from psychoses showing well-defined periodicity who underwent prefrontal leucotomy. They were a small group amongst the 250 patients who have undergone this operation at Crichton Royal from 1943 onwards. Of the 12 patients, 9 were periodic catatonics and 3 manic-depressives. All were long-standing with an average psychotic history of 14 years; their average age at the time of operation was 36 years. It is notable that no fewer than 4 of the group had their first breakdown at the age of 15, 3 others while still in their teens—all by the age of 27. All had undergone various treatments, including thyroxine administration in 2 cases, but with no permanent improvement and no appreciable effect on their periodicity. Short case-histories are appended and a series of diagrams indicating the duration and frequency of the periods of excitement or stupor in the catatonics and the mania or depression in the manic-depressives. The average length of the follow-up after operation is 3 years 6 months.

The operative technique used was that described by Freeman and Watts (1) except that in cases 9 and 10 and in the first operation in case 11 it was modified as follows: the white matter was cut downwards in the coronal plane but not upwards. Instead, a horizontal cut was performed towards the tip of the

frontal lobes, thus isolating the orbital areas only and avoiding epileptogenic areas in the upper part of the frontal lobes. A special communication on the results of the modified operation is given on p. 115.

RESULTS OF LEUCOTOMY.

From the clinical point of view the results of the operation can be summarized as :

Recovered	5
Marked improvement	5
Slight improvement	1
Worsened	1

Of the recovered patients 3 were catatonics and 2 manic-depressives ; the catatonics, Nos. 1, 8 and 11, were aged 40, 41 and 28 at the time of the operation, with psychotic histories of 11, 26 and 8 years respectively ; the manic-depressives, Nos. 10 and 12, were aged 33 and 39 with histories of 11 and 13 years respectively. The cases which showed marked improvement were 4 catatonics and 1 manic-depressive, and the remaining 2 cases, Nos. 6 and 7, were catatonics.

These results are strikingly better than those obtained in the remainder of the patients operated on at the Crichton Royal (2) or reported elsewhere in the literature. It is impossible to dogmatize on such a small group but the results certainly suggest that the periodic psychoses are eminently suitable for treatment by leucotomy.

Even more striking is the result of the operation on the periodicity itself, for in only 1 of the 12 cases did the periodicity fail to disappear completely. The only patient who continued to exhibit periodicity was Case No. 6, a catatonic aged 30, of 6 years' duration who showed some improvement clinically in the sense of amelioration of his symptoms but whose psychosis continued to exhibit its periodicity unchanged. In patient No. 11 it was only after a second operation that recovery took place. At the first operation the horizontal cut had been used, while at the second the incision was extended upwards, thus cutting more of the fibres running between the hypothalamus and the frontal cortex. In one case, No. 7, the periodicity was completely abolished, but as this merely resulted in his psychosis remaining continuously active without free intervals he was classed as having been made worse by the operation.

DISCUSSION.

It is very interesting to speculate on the mechanisms underlying the periodicity in these psychoses and how leucotomy leads to its abolition. The hypothesis put forward by Mayer-Gross (3), that the frontal lobe symptoms produced by the operation bring about a change of personality enabling the patient to overcome the psychotic symptoms applies equally to this small group as it does to all other cases. What this hypothesis, however, does not explain is the abolition of the periodicity in almost all of these cases and even in Case No. 7 where the other symptoms were not appreciably affected. The

role played by the hypothalamus and its connection with the prefrontal area is of particular interest as the probable cause of the periodicity. It points to a special effect of prefrontal leucotomy on the underlying mechanisms.

Gjessing (4) investigated the metabolism of the periodic catatonic and came to the conclusion that the attacks were related to alterations in the nitrogen balance in the body. He treated his cases with thyroxine and claimed to abolish the periodicity provided the thyroxine was continued. He suggested that "at the time of change of phase in a varying nitrogen balance, one or more toxic substances are formed, which act through the blood-stream on the vegetative and myostatic centres of the diencephalon." The periodicity is therefore explained as a disturbance of the vegetative nervous system occurring as a result of effects on its centre in the hypothalamus.

It seems almost certain that the hypothalamus is in some way bound up with the changes that occur. In animals in whom both cerebral hemispheres have been removed, periodic discharges occur affecting all divisions of the vegetative system. These discharges are accompanied by signs of anger which have been called "sham rage." The development of these reactions seems to depend on the posterior hypothalamic nuclei, for when these are removed the reactions no longer occur (5).

That the hypothalamus may well play an important role in the activities of the frontal cortex is clearly shown in an informative article by Le Gros Clark (6) dealing with the connections of the frontal lobes, in which he demonstrates that there is a most intimate two-way relationship between the frontal cortex and the hypothalamus. He points out that the work of Meyer *et al.* (7) on leucotomized brains makes it very probable that the findings of Mettler (8) in lower primates are applicable to man. Mettler found that the dorsomedial nucleus of the thalamus connects with all the Brodman areas from 8-12 in the frontal lobe of the monkey. Le Gros Clark further brings evidence to show that the dorsomedial nucleus can be regarded as a relay station for the transmission of impulses originating in the hypothalamus. He states that the greater part of the frontal cortex must be regarded as a projection area receiving the products of activity of the hypothalamus, in the same way that the visual cortex is the projection area for retinal activities or the auditory cortex for cochlear activities. He brings forward evidence that there are also direct efferent connexions from the cortex to the hypothalamus.

The above facts certainly make feasible the contention that periodic psychosis has its periodicity imposed upon it by the hypothalamus acting through the above mentioned connections between it and the frontal lobe.

It does not follow from this that the primary seat of the disease is in the hypothalamus; it may be anywhere in the central nervous system or in the rest of the body. Nor does it contradict the finding that the failure is in the sphere of nitrogen metabolism as Gjessing maintains, who himself refers to a participation of the vegetative centres of the diencephalon. What is suggested is that the time pattern of these psychoses is imposed by the hypothalamus on the cortex and that by prefrontal leucotomy this periodicity is abolished by the severance of the fibres connecting the hypothalamus to the cortex which subserve this periodicity.

It would be interesting to know if the rhythmic metabolic disturbance found by Gjessing in the periodic catatonia persists after operation. If it does, its influence on psychological behaviour is presumably abolished by cutting the connexion between the hypothalamus and the frontal brain. If, as is more probable, the nitrogen cycle returns to normal and is abolished by the operation it would suggest that it is really the cortex and its abnormal influence on the diencephalon which produce the cycle, in which case the "seat" of the illness would be in the cortex. This latter possibility would be comparable to the cure of gastric ulcer by the cutting of the vagus above the stomach, an operation which acts by abolishing the noxious influence of the higher centre on local autonomic regulations.

Another possible line of speculation is as to which of the group of fibres to and from the thalamus and cortex require to be cut to abolish the periodicity. Case 11, in which the upward cut abolished the periodicity, after the horizontal cut had parted, would appear to suggest that only the fibres involved in the upper cut are important. This, however, is negatived by Cases 9 and 10 in which the horizontal cut abolished the periodicity. Equally important is the undoubted fact that in a blind operation such as leucotomy it is impossible to say with any certainty which fibres have been cut in any particular operation. The general conclusion from the present series of operations seems to be that several of the groups of hypothalamic-cortical and cortical-hypothalamic fibres subserve the periodicity, and that the cutting of some or any of those groups of fibres is sufficient to abolish the pattern subserving the periodicity.

In conclusion it should be emphasized that while the clinical results recorded are factual, the conclusions drawn from these facts in support of the hypothesis that the hypothalamus plays an important role in the periodicity of the psychoses are admittedly tentative.

SUMMARY.

The results are reported of the effect of leucotomy in 12 cases of periodic psychoses, 9 catatonics and 3 manic-depressives. Five cases recovered and 5 showed marked improvement.

Periodicity was abolished in all but one case. One case was made worse in that the psychosis became continuous instead of periodic.

The role of the hypothalamus in the phenomenon of periodicity is discussed.

We wish to thank the various members of the medical staff of the Crichton Royal whose cases have been used in this paper and particularly Dr. W. Mayer-Gross for his helpful criticisms.

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CASE HISTORIES.

CASE 1.—A. D— (male), aged 40 at operation. This patient was an estate and farm worker. His father had been an alcoholic, but there was no other history of mental illness or psychopathy in the family. He was an average scholar and had a good work record. He started drinking heavily at the age of 20, and in 1932, when 29, he became excited, incoherent and confused after a bout of drinking. He continued mentally ill till his admission to hospital in August, 1933. Periods of catatonic stupor alternated with periods of well-being, when he was allowed on parole and worked on the hospital farm. Each period lasted about a month. He was discharged to the care of his parents in November, 1935. After discharge he stayed at home and the periodicity of his illness continued. When well he worked in the house or farm and when ill he became either excited or stuporose.

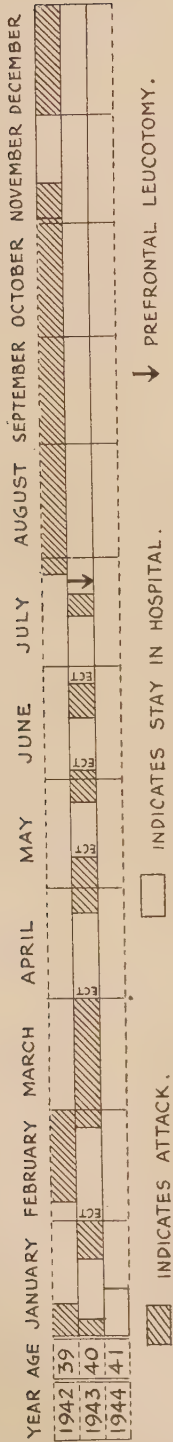
In 1942 he had a period of well-being lasting 5 months, followed by a period of catatonic stupor lasting 4 months. During the latter he was re-admitted to hospital. E.C.T. was started in January, 1943, but the only effect of this was to shorten the attacks without affecting their periodicity.

Prefrontal leucotomy was performed on 25.vii.43, the coronal cut being used. Some pyrexia followed the operation and he was rather restless and confused for a few weeks. He had a single epileptic fit on 30.viii.43. He had no catatonic attacks subsequent to operation. His progress to complete social recovery was uninterrupted and he was discharged in January, 1944. He has continued to do well. There has been no suggestion of relapse and no evidence of any changes of mood or behaviour pointing to periodicity. He is working as a joiner in an Electric Power Company and his work appears to be quite satisfactory. He married a school-teacher in April, 1947, and seems to have made a satisfactory adjustment to his marriage. This case is classed as "Recovered."

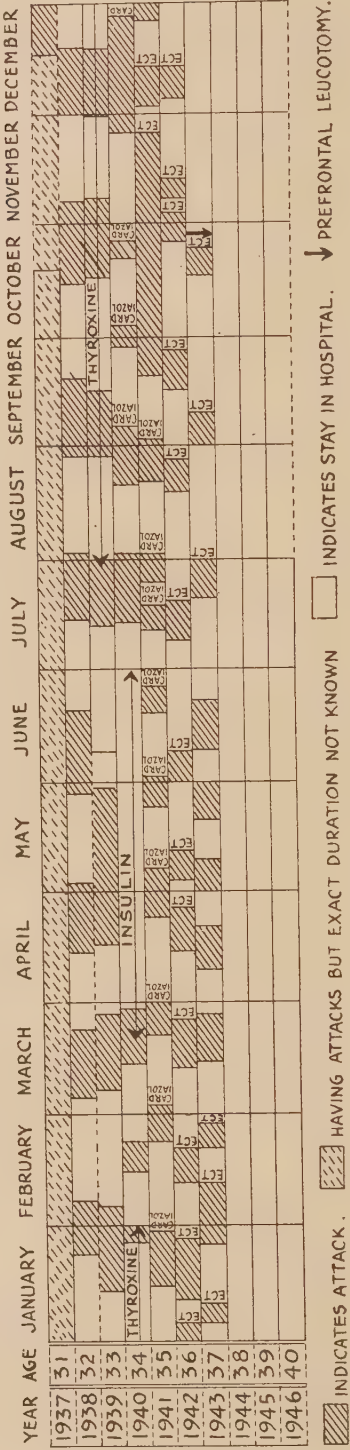
CASE 2.—B. P. M. B— (female), aged 32 at operation. This patient had her first breakdown in 1926, at the age of 15. A maternal uncle and cousin had suffered from schizophrenia. A paternal aunt suffered from puerperal mania and a paternal uncle committed suicide. After a childhood spent in India she was sent to a boarding school in England. She enjoyed school and was considered by her teachers as sweet tempered but only fair at her work. She had to leave school at the age of 15, as she was already showing signs of mental instability, and soon afterwards she was admitted to Bethlem Royal in a state of catatonic stupor. She had a fairly good remission from this first attack, but broke down again later and from the age of 20 has been continuously in mental hospitals. She was admitted to Crichton Royal on 9.v.38. Her psychosis was characterized by episodes of catatonic excitement in which she became very violent. At first these attacks lasted a few days to a few weeks, and between them she was quiet and childish but pleasant and co-operative. Her better periods gradually decreased and the periods of excitement increased as she grew older. E.C.T. when first administered helped to shorten her attacks but in time failed to have any appreciable effect on her behaviour.

Prefrontal leucotomy was performed on 18.ix.43, the coronal cut being used. There were no post-operative complications and her convalescence was uneventful. She repointed well to rehabilitation and made slow but steady progress to a condition which could be regarded as social recovery as far as her life in hospital was concerned. She is still solitary and somewhat lacking in interest in outside affairs, but she gets on well with her fellow patients, helps the nurses in the ward, is on full parole and takes an active part in occupational and recreational therapy and in all the social activities of the hospital. She has no relatives in this country, otherwise she would be very suitable to live outside hospital. This case is classed as "Marked Improvement."

CASE 3.—I. D. S— (male), aged 37 at operation. This patient was admitted to hospital for the first time in 1939. He had always been a rather solitary type



CASE No. 1.



CASE No. 3.

and did not mix well in school. He did not play games and would not face up to his difficulties. His mother had had a "nervous breakdown" and one maternal uncle was an epileptic and was in a mental hospital. After leaving school the patient worked in a bank for 3 years but was advised to leave as he did not fit in well. He then worked as a clerk but soon after, at the age of 19, he had his first breakdown. Thereafter he had numerous attacks of a catatonic type up to the time of his admission to Crichton Royal at 33 years. Before admission the catatonic phases lasted for two or three weeks with intervals of normality of three or four weeks. Thyroxine, insulin, cardiazol and E.C.T. were given but with no permanent improvement. He was able to work in the ward or garden between the catatonic attacks. E.C.T. and cardiazol shortened the attacks but increased their frequency.

Prefrontal leucotomy was performed on 28.x.43, the coronal cut being used. He was rather irritable for the first few weeks following the operation, but later he improved greatly and periodicity was abolished. He worked on the farm or in the garden, but was always rather lazy. He was discharged on 31.vii.46.

Since his discharge he has not done too well. He has maintained his improvement but still exhibits symptoms of the frontal syndrome. He has tried many jobs but has been unable to maintain any of them for any length of time. He is irritable at home and upsets his old mother and sister with whom he lives. No periodicity in his symptoms is in evidence and this must be regarded as abolished. This case is classed as "Marked Improvement."

CASE 4.—M. C— (female), aged 29 at operation. This patient's first breakdown occurred in 1931 at the age of 17. She was admitted to Crichton Royal at that time and on three subsequent occasions. She has also been a patient in Garlands Mental Hospital. There is no family history of mental illness or psychopathy. She was never able to maintain an outside job for long and more generally helped her father on his farm. She always tended to be rather irritable at home between attacks. She was in hospital continuously from 1940. While in hospital, she had catatonic attacks when she was either semi-stuporose or noisy and restless. They were variable in length and lasted from a week or two to a month or longer, with relatively well periods between which sometimes lasted a few months. When well, she was allowed ground parole, took part in the social activities of the hospital and helped with the ward work. Both E.C.T. and cardiazol cut short the attacks.

Prefrontal leucotomy was performed on 16.xii.43, the coronal cut being used. No complications occurred. Her steady improvement was uninterrupted. She did domestic work in the hospital and took part in gymnastics, swimming and social activities. There was no sign of the former catatonic attacks.

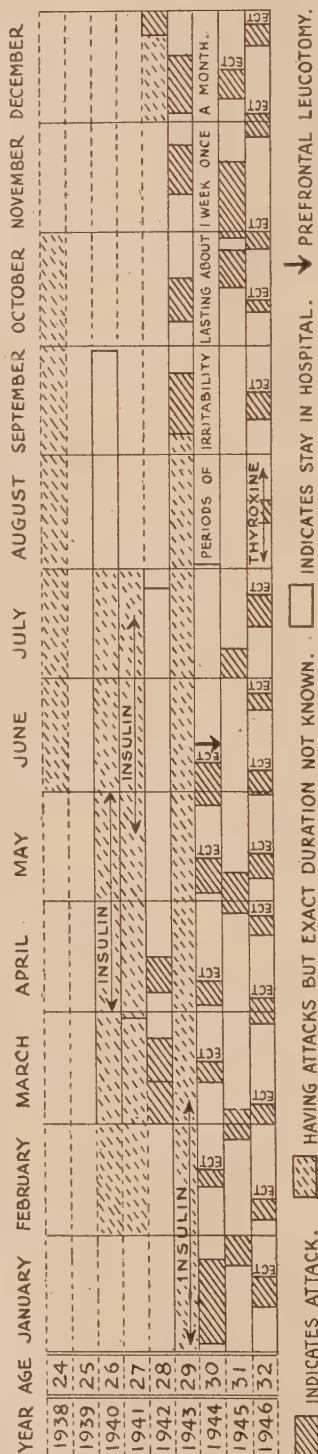
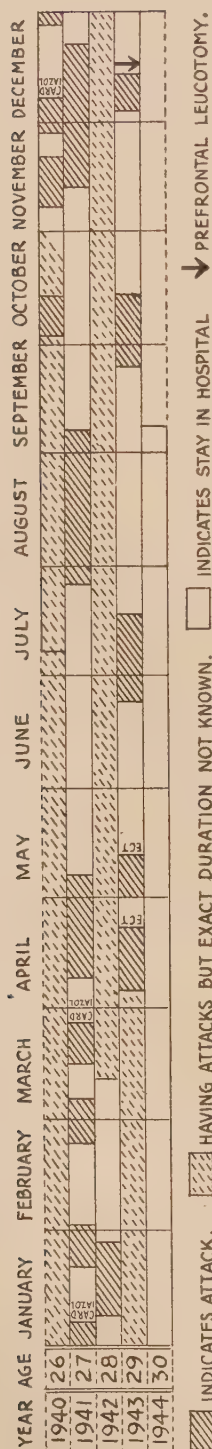
Since discharge she has been helping her father on the farm and doing odd jobs at home. She is rather slow and does not mix readily but goes out a good deal; she attends Church and helps with various charities. She is stubborn and somewhat irritable at times but this shows no periodicity.

In this case, periodicity has been abolished and there has been marked improvement to a level closely approximating to her prepsychotic level.

CASE 5.—A. W— (female), aged 50 at operation. This case was one with a long history of manic-depressive attacks. After leaving school she lived at home. She is reported to have had excitable periods for a month or more every year from her early teens. She was always quarrelling with the various members of her family and was said to have delighted in stirring up trouble between them. Her first admission to a mental hospital was at the age of 34 when her family could no longer control her in her attacks.

She was admitted to Crichton Royal in 1935, at the age of 41 with a history of elation and excitement of two weeks' duration. During her whole stay in hospital her condition varied between depression and noisy elation with short periods of apparent normality. Cardiazol and E.C.T. cut short her attacks but without any permanent improvement.

Prefrontal leucotomy was performed on 5.v.44, the coronal cut being used. There was marked improvement following this and she remained stable with no mood swings until two years later when in June, 1946, she passed into a hypomanic phase which lasted a few weeks. This attack cleared up but she had another hypomanic phase in August, 1946. She remained well after this and was discharged from hospital in July, 1947.



Since then she has stayed with her brother and has been very well. She retains her selfish, unaccommodating, prepsychotic personality but without any evidence of mood swings. This patient could be regarded as a social recovery but as she relapsed after two years' normality following her leucotomy, for the purpose of this paper she has been classed as a case of "Marked Improvement."

CASE 6.—N. E. B— (male), aged 30 at operation. This patient was first admitted at the age of 26. He was an architect and had been a brilliant student, taking many prizes. He was quiet, industrious and did not easily make social contacts, especially with women. His elder brother was a mongol defective but apart from this, there was no family history of mental illness or psychopathy.

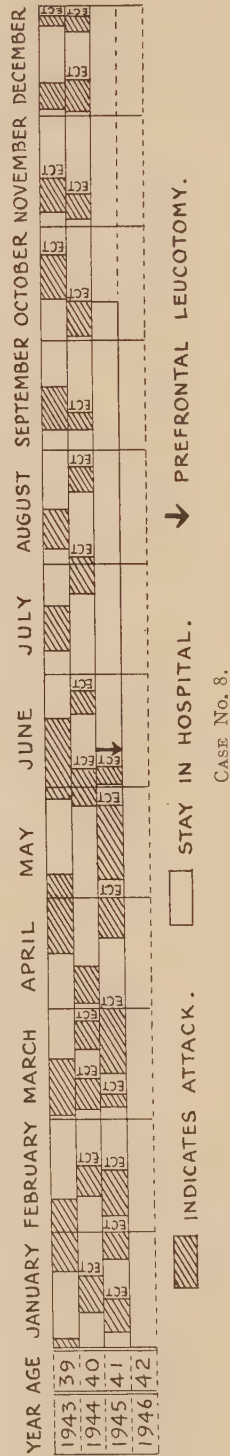
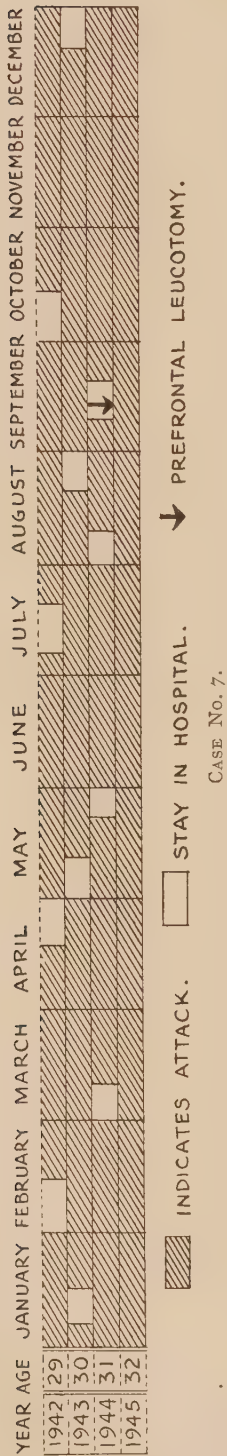
His first breakdown occurred at the age of 24, six years before the operation. He recovered from this attack and carried on with his work. The next breakdown occurred in 1940, when he was 26. He had been in the Army for a year but had no foreign service. He responded to insulin treatment and was discharged from the Army in August, 1940. He went back to his work and remained well until January, 1941, when he again broke down. He was admitted to Crichton Royal in March, 1941, in a state of severe catatonic excitement. He improved greatly with a course of insulin and was discharged. He was re-admitted on two occasions, the second after having been in Holloway Sanatorium for some months. There, as during his second stay in the Crichton Royal, his condition had alternated between catatonic excitement or stupor and periods of comparative normality. He had again been given insulin. This periodicity continued after his re-admission to Crichton Royal and it was found that the catatonic attacks lasted about 21 days, with seven to twenty-one days between when he was fairly well. E.C.T. shortened the catatonic attacks.

Prefrontal leucotomy was performed on 15.vi.44, the coronal cut being used. There were no complications following the operation. For some months after this he showed improvement. He had spells of irritability and slowness which lasted approximately a week once a month, but no real catatonic attacks occurred until February, 1945. Thereafter, the attacks gradually resumed their former periodicity and he now has to have maintenance E.C.T. every four to six weeks. Between the attacks he is able to go out in the grounds, change his library books in town and keeps himself occupied. A course of Thyroxine was started in August, 1946, but without appreciable benefit. The only improvement in his mental condition is that his catatonic attacks are much milder than prior to the operation. This case has been classed as "Slight Improvement."

CASE 7.—H. P. M. W— (male), aged 31 at operation. This patient had his first breakdown at the age of 17 while still attending school. He had a shut-in personality and never made friends easily. No family history of mental illness but mother is schizoid type. He recovered from his first attack and worked on a farm but continued to have attacks of depression with religious delusions. He was admitted to the Crichton Royal in January, 1932, and has been there since. His psychosis followed a fluctuating course with aggressive destructive periods alternating with bright periods when he was sociable, occupied himself and enjoyed parole. His excited phases were shortened by cardiazol but the periodicity was not appreciably affected. His clinical notes show that in 1942 he had two weeks' relative remission every two to three months, in 1943 about ten days every three to four months, and in 1944 every two to three months. This was his condition when he was operated on (coronal cut) on 14.ix.44. His convalescence was uneventful but he became inaccessible, slovenly, destructive, aggressive and without initiative. There was and still is complete abolition of his good phases.

Four years after operation he is no longer aggressive or destructive. He does rugmaking but remains mute and inaccessible. This case is classed as "Worse after Operation."

CASE 8.—A. K— (male), aged 41 at operation. This patient had his first breakdown at the age of 15 and was admitted to Crichton Royal for the first time in 1919. There is no history of mental illness or psychopathy in the family except that one brother died after a "fit" following pneumonia. On the first occasion he was discharged after three months but was re-admitted on eleven subsequent occasions. His father was a farmer and was very sympathetic to the patient, and during the times when he was out of hospital he worked on his father's farm. For



26 years before his leucotomy his condition alternated between catatonic phases when he was noisy and restless, or stuporose, and periods when he was relatively well, when he could work on the farm or gardens. The catatonic phases usually lasted 10 to 14 days, with intervals of about three weeks, when he was comparatively well. After his father's death he did not leave hospital when he was fairly well but remained working on the hospital farm. Latterly it was found that the catatonic phases were cut short by E.C.T. but their frequency gradually increased.

Prefrontal leucotomy was performed on 7.vi.45, the coronal cut being used. No serious complications followed the operation. He made excellent progress and no catatonic attacks have occurred since. He left hospital on 10.x.45, and went to work as a dairyman. He stayed in his first job for eighteen months and then went to a better job which he still holds. He earns a full wage and has a good deal of responsibility. He lives a normal life, likes going to the pictures and enjoys an occasional glass of beer. There is no evidence of periodicity in his moods or behaviour. He makes a normal impression and the operation is regarded by his family as an outstanding success. This case is classed as "Recovered."

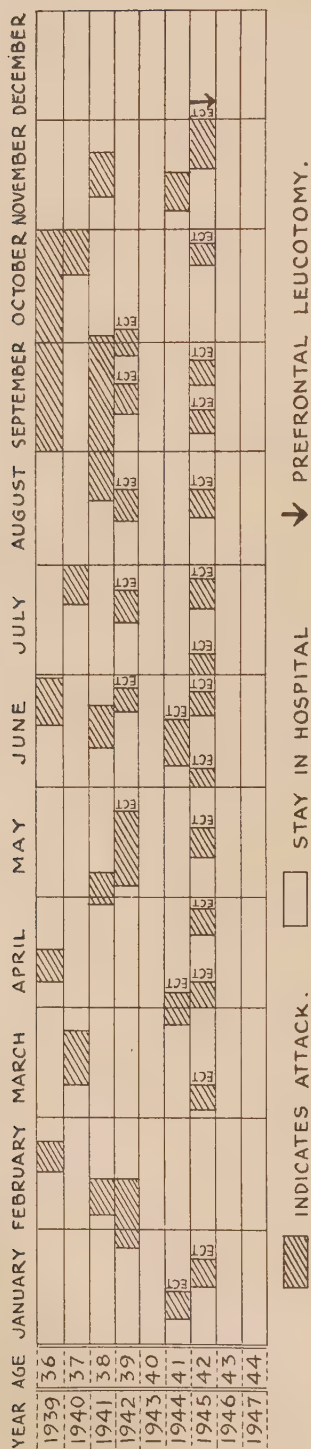
CASE 9.—T. L. M— (male), aged 42 at operation. This patient had been a butcher's assistant in the family business. He had always been rather quiet and did not make friends easily, though he was pleasant and popular in the family. He was always kind and obliging and a reliable worker. There was no family history of nervous illness or psychopathy. For about one year before his breakdown a change in character was noticed, and he gambled and became generally irresponsible. In 1931, at the age of 28, he became definitely psychotic, with ideas of reference, auditory hallucinations and odd behaviour. He was admitted to his local mental hospital and later transferred to Crichton Royal with a history that he had been having psychotic attacks, with intervals when he was fairly well and worked on the hospital farm.

After coming to Crichton Royal he had periodic attacks of catatonia when he would become withdrawn and almost stuporose, with intervals between when he could work on the farm and gardens. The catatonic episodes usually lasted for a few days and occurred every few weeks, but sometimes the catatonic attacks and the intervals lasted longer. These attacks were cut short by E.C.T., but for about two or three years before operation he required maintenance E.C.T. every few weeks.

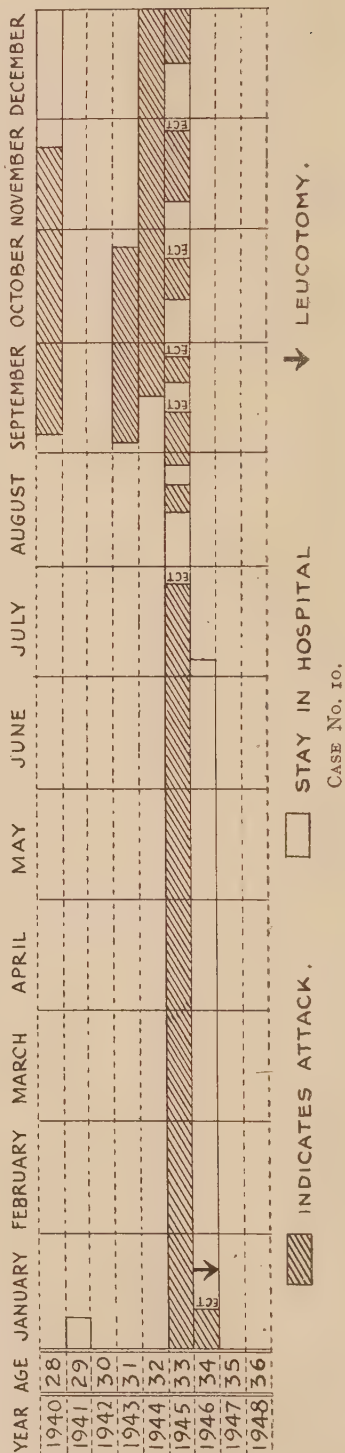
Prefrontal leucotomy was performed on 6.xii.45, the horizontal cut being used. He made steady progress after an uneventful convalescence; the periodicity has been completely abolished and there has been marked improvement in his mental condition. However, he is averse to leaving hospital and shows some emotional flattening and lack of spontaneity. He helps with the ward work, attends O.T. classes, has full parole and takes part in the various social activities of the hospital. This case is classed as "Marked Improvement."

CASE 10.—J. S— (female), aged 33 at operation. This patient came to this country as a refugee from Vienna in 1938. Her mother and father were both dead. Her father was said to have been very nervous. There was no other history of psychopathy in the family. The patient's temperament was described as "highly strung." She was trained as a shorthand typist, always made friends easily, and liked dances, parties and social life generally. At the age of 22 she developed a psychosis with insomnia and depression and was in a mental hospital in Vienna for 2-3 months. After coming to England she first worked as a domestic help and later obtained a post in a private hotel. Following a disagreement with an Air Raid Warden in September, 1940, she became agitated, noisy and deluded. She was certified and remained in hospital till early in 1941. She was admitted to hospital again in 1943 and 1944. The last admission followed an exploratory laparotomy. She was transferred to Crichton Royal in July, 1945. On admission she was mute, immobile and hallucinated. Repeatedly she responded to E.C.T. only to relapse later, becoming noisy and excitable or depressed. After thorough investigation and observation it was finally decided that in spite of some schizophrenic features the case was fundamentally one of manic-depressive psychosis with attacks of increasing frequency and severity.

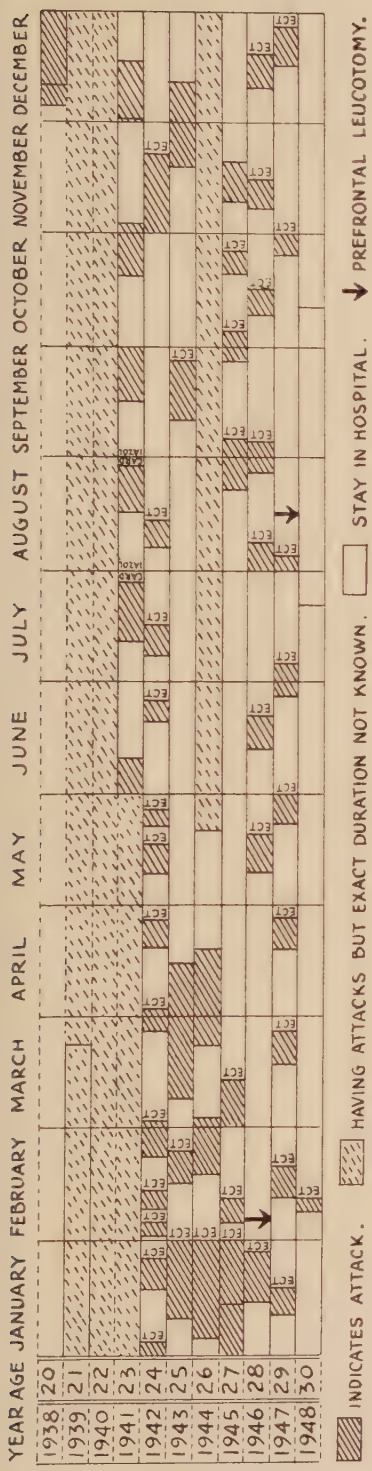
She underwent the operation of prefrontal leucotomy (horizontal cut) on 24.i.46, and no complications followed. She improved steadily and in due course worked



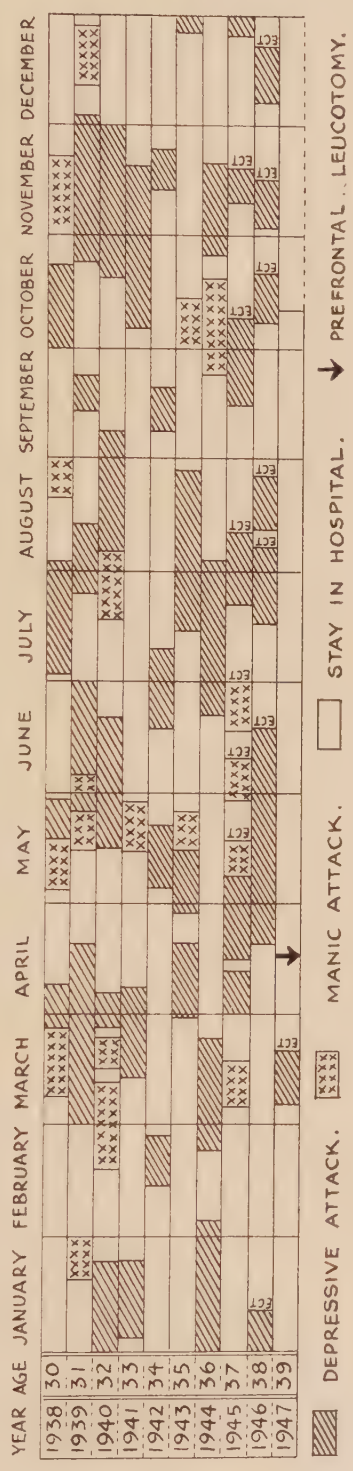
CASE No. 9.



CASE No. 10.



CASE NO. 11.



CASE NO. 12.

in the office and later in the gardens. She made adequate arrangements for her own discharge and left on 5.vii.46.

On discharge she returned to hotel work. She has had no relapses and on interview recently presented a picture of complete normality. There is no evidence of any abnormal fluctuations of mood and the patient is happy in her work and has been able to do it well for over 2 years. This case is classed as "Recovered."

CASE 11.—M. H— (female), 27 years of age at first leucotomy, 28 years of age at second leucotomy. Before her first breakdown this patient had been a nurse-maid and had been quite successful at her work. The only unusual feature noted in her personality was a marked religious tendency. She had "seen the light" and had been converted at the age of 15, after which she had been an ardent attender of Gospel meetings, etc. She was the youngest of six children. One brother died in Crichton Royal at the age of 26, after having been a patient for only one week. There was no other history of mental illness or psychopathy in the family.

The patient first became definitely psychotic at the age of 20. She had been looking after a baby and had been in the post for two years. She became quiet, depressed and confused, and was in hospital for 3 months. She had not fully recovered at this time but remained at home for two years, during which time she had episodes when she became very depressed and silent for a few weeks followed by periods of over-activity. She was admitted to Crichton Royal in a stuporose condition in 1941 at the age of 22. After two weeks she became bright and active. She said that during the stuporose periods she was in communication with God and heard His voice. A diagnosis of periodic catatonia was made. She had another attack of stupor after a further five weeks. Thereafter she was treated with cardiazol and E.C.T. which shortened the attacks to two or three days with intervals of two to three weeks when she was comparatively well.

Although she had not recovered she was discharged on 18.v.44, and was able to remain at home till 14.i.45. She had had a stuporose attack while at home and was in a state of severe stupor on her return to hospital. She continued to have frequent attacks of stupor and over-activity.

Prefrontal leucotomy (horizontal cut) was performed on 7.ii.46. She remained very quiet after this and had to have further E.C.T. from May, 1946, onwards. Two or three convulsions would produce marked improvement and she would remain well for about four weeks.

A second leucotomy in which the cut was completed upwards, was performed on 17.vii.47. After a period of comparative normality when she was somewhat asocial and giggly in October, 1947, she became semi-stuporose as she did for short periods on two subsequent occasions. The last of these was in February, 1948. Since then she has been very well. She became most helpful in the ward, cheerful, sociable and entered with enjoyment into the social and recreational facilities of the hospital. She was discharged on 26.vii.48. Since then she has kept very well and is now working in her own home looking after her mother. There has been no evidence of mood swings or periodic changes of behaviour since February, 1948. This case is classed as "Recovered."

CASE 12.—A. M— (female), aged 39 at operation. This patient was the daughter of a missionary who had died young, apparently following some psychotic illness of which no details are known. The patient's pre-psychotic personality was good; she had always been artistic and had studied and written poetry. She was a qualified teacher. She first broke down at the age of 26, following unhappiness at her work.

She was admitted to Crichton Royal in 1937, at the age of 29. For some years after admission she had very frequent attacks of mania or depression with only short intervals of a few weeks between, when she was relatively well. Later the manic and depressed phases occurred less frequently. E.C.T., started in 1944, cut short both manic and depressive attacks but did not influence their frequency.

Prefrontal leucotomy was performed on 17.iv.47, the coronal cut being used; no complications followed. At first she showed inertia and mild euphoria but these symptoms gradually disappeared. She was able to join in all the hospital activities and there was no sign of her previous attacks or of any mood swings. She was discharged from the hospital six months after operation and is still doing well. At a recent interview she presented a picture of normality. This case is classed as "Recovered."

RESULTS OF ISOLATION OF THE ORBITAL LOBES IN LEUCOTOMY.

By GEORGE EGAN, M.B., D.P.M.

From the Department of Clinical Research, Crichton Royal, Dumfries.

MANY authors, examining personality changes after brain injury, have observed that lesions of the orbital surface of the frontal lobes are more frequently accompanied by emotional changes than lesions in any other part of the cortex. Amongst others, Schuster (1902), Berger (1923), Kleist (1931) and Rylander (1939), have called attention to this fact, and experimental work by Fulton and Ingraham (1929) on cats has established confirmatory evidence. Freeman and Watts (1942), in their study of leucotomized patients observed that, if only the lower quadrants of the white matter in the prefrontal area were cut, the results of leucotomy were better than when the cut was placed in the upper quadrants only. Groups of cases, in whom only the lower quadrants were sectioned, have also been reported on by Dax and Radley Smith (1943 and 1946), Reitman (1946) and Hofstatter *et al* (1945).

This paper deals with a series of 52 patients treated by a modification of the operation, introduced to effect a more complete isolation of the orbital lobes.

OPERATIVE METHOD.

After introducing the leucotome in the level of the burr hole, the white matter was cut downwards, towards the basis of the brain, but the cut was not



Diagram illustrating plan of cut in modified leucotomy

continued upwards towards the convexity. Instead, the leucotome was turned horizontally and guided forward, cutting the white matter towards the tip of the frontal lobes. Thus the orbital areas were isolated without interfering

with the fibres leading to the upper parts of the frontal lobes. By this modification it was hoped to come closer to the problem of localization of the desirable leucotomy changes, and also, by avoiding the epileptogenic zones of the frontal lobes (areas 6 and 8 of Brodman), to eliminate the complication of post-operative epilepsy.

CASE MATERIAL.

The group consists of 52 patients, 26 female and 26 male, unselected, except in so far as they showed the usual indications for leucotomy (see Berliner *et al.* 1945). They were all operated on between November, 1945 and October, 1946. The duration of the illness at the time of operation varied from three years to forty years. The average for the total group was 10 years. Fourteen of the patients had been ill for fifteen years or more. The period of hospitalization varied from one to fifteen years, giving an average of about four years. Six patients had been ten or more years in hospital. The patient's age at the time of operation varied between 20 and 66 years, with an average of 35·1. Fifteen of the patients were between 20 and 30 years, 20 between 30 and 40, 13 between 40 and 50, and four were over 50.

DIAGNOSTIC SUB-GROUPS.

Forty-one of the total group suffered from schizophrenia, six from affective psychoses, three from an obsessional neurosis and two from a post-encephalitic syndrome. In two of the schizophrenics and in one depressive the psychosis was superimposed on a high grade mental deficiency.

The schizophrenic group was made up of the following sub-types: hebephrenic 13, catatonic 7, paranoid 13, schizophrenia simplex 3, and paraphrenia 5. Of the six classified under the heading of affective psychoses, four showed periodic alterations of mood, two being predominantly manic and two predominantly depressive. One patient suffered from an intractable involutional melancholia, and the remaining patient of this group was a chronic depressive of low intelligence with additional obsessional rumination and rituals.

Two of the three patients in the obsessional group suffered from a straightforward obsessional illness of many years' duration. In the third patient, although the presenting symptoms were in the obsessive-compulsive sphere, the clinical picture was complicated by the recent development of paranoid ideas; these were, however, so closely linked to the obsessional symptoms that a diagnosis of schizophrenia was rejected, although some clinicians would probably have favoured such a label.

COMPLICATIONS.

A single major epileptiform convulsion occurred in two patients, one ten months and the other fourteen months after the operation. The patients were suffering from schizophrenia, which in both cases had developed on the basis of high grade mental deficiency. No evidence of epilepsy could be traced in their previous personal or family histories. There were no fatalities in the series.

TRANSIENT ALTERATIONS IN MOOD OR PERSONALITY AFTER THE OPERATION.

Restlessness and irritability were the most frequent post-operative changes noted. Two patients were so restless that continuous narcosis had to be instituted for the first two weeks. Outspoken abusiveness and obscene language, in patients previously without such inclinations, were observed five times, in one case persisting for nearly four weeks. Transient hypomanic elation was observed in four other patients. Negativism was a marked feature for a short time in two cases. Attention has been called to such temporary disinhibition phenomena by Frank in his study of 200 cases. Post-operative drowsiness occurred in four cases; transient inertia and listlessness, which quickly vanished, was observed in three others. Post-operative confusion was rare, occurring in three cases only. Temporary incontinence was present four times. Over-politeness, as described by Frank, was found five times.

ANALYSIS OF RESULTS.

Twenty-six of the fifty-two patients are at present living outside hospital; twenty-one are still in this hospital, and five have been transferred, or re-admitted, to other hospitals. Of the twenty-six living outside, eleven are gainfully employed and six are fully occupied in their own homes, four of them having taken on full housekeeping responsibilities. Eight are idle. One of the eleven gainfully employed has been moved up the occupational scale since the operation, three have moved down, and seven are doing the same work, or something similar to what they did before their illness. The results of the total group are as follows:

Recovered . . .	8
Much improved . .	9
Improved . . .	6
Slightly improved .	15
No change . . .	13
Worse . . .	1

Thirty-eight patients can therefore be said to have benefited to some extent from the operation.

The following table shows the results in the different diagnostic sub-groups:

TABLE I.

Result..	Schizophrenia.	Affective psychoses.	Obsessional.	Post-encephalitic syndrome.
R.	5	2	1	0
M.I.	4	2	2	1
I.	6	0	0	0
S.I.	15	0	0	0
N.C.	11	1	0	1
W.	0	1	0	0
Total	41	6	3	2

An analysis of the results of the schizophrenic group is shown in Table II. The five paraphrenics are included with the paranoid group.

TABLE II.

Result.	Hebephrenic.	Catatonic.	Paranoid.	Simplex.
R.	1	2	2	0
M.I.	1	0	2	1
I.	2	2	2	0
S.I.	6	1	7	1
N.C.	3	2	5	1
Total	13	7	18	3

Of the total group of schizophrenics, five are classified as recovered, four as much improved, and six improved. The remaining twenty-five are either only slightly improved or have shown no change. Twelve of the group of 18 patients classified as paranoid schizophrenia or paraphrenia have also failed to benefit to any marked extent from the operation. The improvement rate of one-third of the hebephrenic group is more or less in accordance with the findings of other writers, but the same figure for the paranoid group is rather low. The numbers are, of course, small for valid comparisons, but the rough percentage figure of 33 per cent. compares very unfavourably with the improvement rate of 75 per cent. reported by Frank in his study of 200 cases. In three patients the psychosis showed a regular periodicity pre-operatively; in two of them the operation has abolished the periodicity at a good level of behaviour. The third patient continued to show the same rhythmic relapses after the operation, but a second operation, using the conventional coronal cut, performed 18 months later, has had a favourable result (Jones and McCowan, 1948).

Three other patients in the series, two manic depressives and one schizophrenic, had a pre-operative history of recurrent psychotic attacks alternating with periods of normality. The periodicity, however, was not completely regular. Two of these patients have been free from attacks since the operation, thus enjoying a longer remission than previously. The schizophrenic has had one relapse since the operation, after a lapse of 18 months of normality, during which he was gainfully employed outside. This was longer than either of his two immediately previous remissions. Furthermore, his stay in hospital on the occasion of his last relapse was shorter than previous ones, and he remitted without the aid of physical treatment.

The group of obsessionals seems rather small to justify separate analysis, but it can be enlarged by including three others, two schizophrenics and one chronic depressive, all showing obsessional symptoms. In all six cases the obsessional symptoms have more or less persisted, despite the operation. The patient classified as a social recovery was completely relieved of her symptoms for some weeks after the operation. Within six weeks, however, she was again giving in to her rituals, contamination phobias, etc., and only after a short course of convulsive therapy, much supportive psychotherapy, and six months'

rehabilitation in hospital, was she able to overcome her symptoms. She is even now not symptom-free. In the two cases classified as much improved there was the same initial period of freedom from symptoms, followed by a relapse and thereafter very slow progress. In both cases obsessional symptoms are still conspicuous and to some extent incapacitating. The other three cases were also temporarily relieved of their obsessive-compulsive symptoms, even for as long as three or four months, but they have now completely relapsed and are classified as unchanged.

Of the two patients suffering from a post-encephalitic syndrome, one is much improved and, were it not for the fact that her physical symptoms have become more incapacitating, she might have been classified as a recovery. The other patient has remained unchanged, despite a second operation (coronal cut).

The influence of the operation on the group of symptoms comprising aggressiveness, destructiveness, and impulsive or violent behaviour, has been examined separately. It was found that these symptoms dominated the clinical picture pre-operatively in 20 of the 29 patients now classified as only slightly improved or unchanged. In the group classified as recovered, much improved, or improved—a total of 23—this group of symptoms occurred pre-operatively in six and has persisted to some extent in two.

Relapse to pre-operative level, after improvement lasting from 6 to 12 months, has occurred in 10 patients; seven of these are in the paranoid schizophrenic group. In many patients still in hospital the psychosis has progressed unchecked with signs of deterioration.

POST-OPERATIVE PERSONALITY CHANGES.

For the study of the post-operative changes in personality, those discharged from hospital were followed up by letter, as described by Frankl and Mayer-Gross (1947). Those still in our hospital have been examined by personal interview, and those transferred or re-admitted to other hospitals have been reported on by the psychiatrists in charge.

(1) *Discharged Patients.*

With only one exception the patients reporting on themselves have written in a cheerful, optimistic strain, indicating that they are very pleased with their condition. In letters from relatives or other observers the happy, care-free disposition of the patients was almost universally commented upon.

Restlessness and hyperactivity come next in order of frequency amongst the points noted by relatives. These features show themselves in the frequent changes of employment and in the diversity and multiplicity of interests and hobbies which the patients have. One patient has had six jobs in twelve months, as well as having applied for admission to two training courses. Another had to keep an engagement book to cope with her many social activities.

The majority of the patients discharged were anxious to find work. In only two instances was a preference shown to remain idle. One of these

was said to be lazy and inert; the other preferred to spend his time at the pictures or in restaurants or careering recklessly about the country in a high-power car, sometimes with disregard for traffic regulations.

Over-optimism was shown by the number who applied for admission to special training-courses. One patient talked of studying medicine, although without a secondary school education. Another wrote to us while on a training course and was already contemplating taking on another.

Some relatives found the patients difficult to live with. They were described as rude and inconsiderate, defiant and quarrelsome, or merely tiresome bores. Many patients, however, were said to have become more amenable to suggestion. In those who still had aggressive outbursts, the outbursts were said to be less violent and the patients were more easily pacified. Four patients have gone on improving since discharge, two are said to be less outspoken and tactless now than when they first came home.

The majority manage their own money; two, however, have become irresponsible spendthrifts and squander their money recklessly. One of these is the patient classified as worse.

The patient, R. A—, is now 69 years old and suffered from a hypochondriacal depression for 10 years prior to his operation, which was performed in December, 1945. In his psychosis he had a host of hypochondriacal complaints, became more and more self-absorbed, was surly, ill-tempered and generally negativistic, muttering to himself in obscene language whenever approached. In states of agitation he vindictively destroyed the furniture and walls of his room with any instrument he could procure. Seven months after his operation (July, 1946) he was pleasant, amicable, and euphoric. He co-operated reasonably in hospital and was discharged to the care of his relatives. His behaviour since then has progressively deteriorated. He is rude and insulting to his relatives and employees and filthy in his personal habits, neglecting to bath or shave for months. He has squandered huge sums of money on senseless projects and is a target for enterprising spivs, drones and confidence men.

(2) Patients still in Hospital.

Of this group of twenty-six still exhibiting psychotic symptoms, nine are usefully employed in one of the hospital departments. Some elevation of mood, as compared with the pre-operative level, was found in ten, amounting to a mild euphoria in four. Five patients have become more inert. Increase in self-esteem and lack of self-criticism was a regular finding in patients not rendered inaccessible by their psychosis.

RESIDUAL PRE-OPERATIVE SYMPTOMS.

As already stated, obsessional symptoms have persisted to some extent in all patients in whom they were manifest before operation. Psychotic symptoms, including hallucinations, delusional ideas, and impulsive behaviour, are reported in four cases living outside hospital, but only in two do they present a real difficulty. One patient provoked a scene in a tram because she thought her fellow passengers were laughing at her. Of the group still in hospital, 21 continue to show evidence of hallucinations. In many, impulsive behaviour and destructive tendencies are unchecked, and delusional ideas persist in all members of this group.

DISCUSSION.

It is not easy to find for comparison a suitable control group, i.e. a group operated on by the standard procedure, by the same surgeon, and selected according to the same indications. Preferably it should consist of the same types of case, using the same diagnostic criteria and the same time and method of follow-up.

The group that approached nearest to this ideal was that of 100 cases from this hospital reported on by Berliner *et al.* (1945). There are two main differences between the two groups. Berliner's group were the first hundred patients operated on in this hospital and therefore included a number of cases of the more chronic type. Furthermore, in the same group a shorter period after the operation was allowed, some of the patients having been followed up for three months only at the time of the report, while the patients with the orbital cut were followed up for 18 months at least. Garmany (1948) has recently pointed out that results tend to improve with increase in length of the post-operative period. Both points of difference therefore, should operate in favour of the series operated by the orbital cut. A comparison of the results, however, shows that the crude rate of recovery and marked improvement in this series (34 per cent.) falls considerably below that of Berliner's series (45 per cent.). This difference is not statistically significant, but its validity is emphasized by comparing the results in the paranoid schizophrenics of both series separately. Here the corresponding figures are 22 per cent. and 50 per cent., showing a very definitely significant difference. The results in the affective group appear better in this series, but the numbers are too small for comparison. One has also the impression that obsessional symptoms have not been so dramatically relieved by the modified operation as by the conventional coronal technique.

Over-optimism, boastfulness, self-complacency and elevation of mood, frequently amounting to euphoria, are the most conspicuous features of the post-operative personality. Hyperactivity is another regular finding, showing itself in over-talkativeness, restlessness and a constant clamouring for a change, either in work or environment. Inertia and lack of drive have been remarkably rare, occurring only six times in all, and where found could usually be attributed to the pre-existing psychosis. Rylander's triad of orbital symptoms, viz. extraversion, elevation of mood and over-activity, therefore, predominates in the majority of the patients discharged and hospitalized. Unfortunately, in many schizophrenics the euphoria and restlessness could not be made use of for better adjustment. The excitement only increased aggressiveness and violent behaviour, while delusional ideas persisted. Other patients remained withdrawn and inaccessible, as if the factor of extroversion was too weak to overcome their autism.

It seems that in certain cases isolation of a larger area of frontal cortex than that of the orbital region is needed for a satisfactory relief of the psychosis. The persistence of hallucinations and delusional ideas in cases of the present series suggests that such symptoms can be bleached or extinguished by the standard operation, while the orbital cut leaves them intact. Only if they are deprived

of their power over the patient and live on as pale shadows in the background of his mind—when they exist at all—can restabilization and reconstruction of the personality take place. If this is correct, the purely quantitative theory has to be supplemented, and leucotomy acts not only by adding new symptoms, but also by subtracting symptoms of the psychosis. (Mayer-Gross, 1948).

Recent experimental work on macaque monkeys by Freudenberg, Glees *et al.* (1947) has shown that decrease in aggressiveness was most pronounced after complete lobotomy in the vertical plane, while motor activity was increased by lower orbital cuts in the vertical and horizontal planes. These findings afford confirmatory evidence for our deductions.

The precautions taken to avoid injury to the epileptogenic zones of the frontal cortex have failed to eliminate the complication of post-operative epilepsy. The incidence of this complication in the series is not at variance with that recorded by other writers. A single convulsion occurred in each of two patients many months after the operation, and were therefore not attributable to immediate post-operative cortical oedema or haemorrhage.

SUMMARY.

A group of 52 patients treated by a modification of prefrontal leucotomy was studied. The operation aimed at producing a more complete isolation of the orbital lobes. The orbital triad of symptoms, extraversion, euphoria and hyperactivity, has been found to dominate the post-operative personality. The clinical results are found to be less favourable than those obtained by the coronal section. This is particularly the case in the paranoid schizophrenic group and, to a less extent, in the obsessional group. Such symptoms as aggressiveness, destructiveness or severe excitement are not markedly influenced by the modified operation.

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THE ENVIRONMENT AS A FACTOR IN THE AETIOLOGY OF CRIMINAL PARANOIA.*

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DURING several years of service at Broadmoor and in the prisons the writer saw a number of cases of criminal paranoia, and was impressed by the importance of external situations in the aetiology of the psychosis. The purpose of this short paper is to draw attention to the environmental stresses to which some of these patients have been subjected, and to try to show that criminal paranoia may sometimes be a reaction to an intolerable and inescapable predicament.

Paranoia is often said to be one of the most dangerous forms of insanity, but it is not a very common cause of serious criminality. Cases of true paranoia, as described by Kraepelin, are rarely seen in prisons, and they are as rare in Broadmoor as in other mental hospitals. Paranoid cases in general are not very common, and of 300 consecutive male homicides admitted to Broadmoor only 45 were suffering from a systematized delusional psychosis. The late Dr. W. C. Sullivan, a former Medical Superintendent of Broadmoor, in his book on *Crime and Insanity* suggested that the evil reputation of paranoiacs was based on their attitudes while under restraint rather than on their criminal achievements, and in a series of 66 cases of paranoid crime studied by East, only 12 were crimes of violence to the person. Nevertheless, although the dangerousness of the paranoid patient has perhaps been overstated, the paranoiac is at times liable to commit serious crime, and among 65 consecutive male admissions into Broadmoor the writer found 11 cases of paranoid psychosis, and of these, 5 had been charged with murder and 3 with attempted murder or wounding.

I should perhaps first define what I mean by paranoia. For the purpose of this paper I am using the term paranoia to describe those cases of psychosis in which (a) delusions are the most prominent feature, (b) there is relatively little evidence of other impairment of psychic function, and (c) there is no definite exogenous factor such as alcohol. This definition excludes the so-called alcoholic paranoia. Chronic alcoholic psychosis with delusions is present in a considerable proportion of insane homicides and is a more dangerous disorder, but it presents such characteristic features, at least in its criminal aspects, as to justify one in regarding it as a separate clinical entity. I should also say that I am using the term "crime" in the legal sense of an act or omission which is punishable by law. By criminal paranoia I mean simply

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paranoia associated with such acts or omissions, without reference to the question of moral turpitude or culpability.

The importance of an adverse environment as a causative factor in paranoia has always been an arguable point but, so far as I am aware, it is one which has not impressed forensic psychiatrists. Bleuler regards "paranoia querulans" as arising on the basis of a real injustice and, writing of paranoia in general, says, "The only known symptom of paranoia, the delusional formation, proves to be a reaction form to certain external and internal situations. At all events, it is not a direct result of any process in the brain, or of a constitutional degeneration, and one must assume that at least in the milder cases the disease would not have broken out without being released by an external situation, or at least would not have assumed the same form—invariably we see at the root of the disease a situation to which the patients are not equal, and to which they react by means of the disease."

In the great majority of cases of criminal insanity the psychosis appears to be essentially of constitutional or organic origin, or to be due to some toxic factor such as alcohol. Thus depressive psychosis is probably the most dangerous form of insanity, being present in over 20 per cent. of the male homicides admitted to Broadmoor, and when associated with murder it is usually of the manic-depressive or involutional type; reactive depression rarely gives rise to homicide. But in the case of criminal paranoia I have often been impressed by the strength of the adverse environmental factors, and this appears to apply both to certain cases of paranoidal psychosis, and also to some of those peculiar non-psychotic (or, at least, non-certifiable) paranoidal eccentrics which one sees fairly frequently in prisons. I remember examining at Brixton Prison an old man who for most of his life had been a Hyde Park orator, his particular creed being atheism and anarchy. He was not of a vicious or criminal type, but had come into conflict with the law on a minor charge—I think it was obstructing the police—and the magistrate had evidently thought it a suitable opportunity to have him medically examined. He was a charming and intelligent old man, with the appearance and eloquence of an ancient prophet, but it was clear that with the passage of years his mission to convert the world had become merely a routine job of work and a means of livelihood. He was surprised when he was asked about his childhood, and told me that he was an orphan and was brought up in a workhouse. At the age of 8 years he ran away to try to find his parents, whom he had never seen. He was arrested and charged with stealing workhouse clothing, that is to say the suit he was wearing, and was sentenced to 14 days' hard labour and to six years in a reformatory. At the age of 14 years he was given a Bible, a Prayer Book and half-a-crown and was sent out into the world to earn his living. He did not consciously associate these early experiences with his lifelong creed of militant atheism and anarchy, and I thought it was too late to attempt psychotherapy. It would have been rather cruel to try to show that he had wasted over half a century because of a wrong judgment of society, if it was a wrong judgment, so I wished him luck in his work and we parted as friends. A similar kind of history was to be found in some of the numerous eccentrics who were received into prison as a result of the war, whether they were labelled Fascists, Peace

Pledgers or Conscientious Objectors. I recollect a youth of 18 stated to be a conscientious objector, who was remanded to prison because he refused to be medically examined before appearing before a tribunal. I explained that I had no option but to examine him on admission to prison, and he was quite agreeable to my doing so provided that I did not report my findings to the tribunal. He was suffering from gross rheumatic carditis, with a decompensated heart, was quite unfit for any form of military service and was fully aware of this. He wanted to be a hero, and as the Government had wisely refused to make conscientious objectors into martyrs he had to go a step further and incur punishment by refusing to be medically examined.

In the case of paranoia associated with more serious criminality the mental disorder is sometimes related to an external situation which is so disagreeable as to be, to my mind, almost unendurable. I have no figures to offer as to the frequency of this association, and if I had they would be valueless because what constitutes an intolerable environment is a matter of personal judgment. But in reading through the cases of criminal paranoia which I recorded, I find that in about one-third of them the subject had grave external difficulties which were usually not of his own making, and also that the more closely the psychosis approached a true paranoia, or the further removed it was from the schizophrenic complex, the more obvious was the role of these external factors. I will try to demonstrate how powerful can be these external factors by means of four illustrative cases.

The first case is one of criminal libel. This is perhaps the most typical of all paranoid crimes and, in my experience, is almost always associated with mental abnormality. It is a rare crime, and I have seen only a few cases, but in every case the subject was either a frank paranoiac or an obviously paranoid personality. It is not difficult to see why this should be so. The paranoiac may be regarded as a person whose overgrown ego has led him to attempt what is for him an impossible achievement, and who has disowned his failure and preserved his self-esteem by building up a system of delusions. These delusions are his defence against self-criticism and self-exposure, and his great aim is to keep them active. He welcomes punishment because it serves to strengthen his delusions, and may invite it by committing a crime. The ideal crime for his purpose is one which brings him notoriety and martyrdom, is in harmony with his delusions and is justifiable if his beliefs are true. Criminal libel, directed against his supposed persecutors, fulfils all his requirements.

In the following case the patients' difficulties were so overwhelming that one wonders whether it is necessary to assume that there was any constitutional basis for the development of paranoid delusions.

CASE I.—A man, aged 27, single, was charged with uttering a defamatory libel. He was found to be insane, and was ordered to be detained during His Majesty's pleasure.

There was no neuropathic family history.

The patient was undersized and of poor physique. He had a gross contracture and wasting of the right forearm and hand as a result of some old deep-seated suppuration. He was almost stone-deaf and could lip-read only a little, so that most of the examination was carried out by means of written questions and answers. He gave the following history :

He was born in Scotland and lived there for 21 years. After an elementary education he was apprenticed to a carpenter. When he was 21 and almost ready to start work on his own an accident to the right forearm and hand rendered the limb useless for skilled manual work. He then decided to become a journalist and attended evening classes with this object in view, supporting himself meanwhile by clerical work. Four years later he got his first job as a reporter, but within a few weeks he developed bilateral otitis media which left him completely deaf. He then obtained work as a collector for a Deaf and Dumb Society, and did some clerical work, but for some reason he lost this post. He then held several clerical jobs for short periods and also attempted, unsuccessfully, to earn a living by teaching journalism by correspondence.

The patient was charged with sending scurrilous postcards to the secretary of the Deaf and Dumb Society which had formerly employed him. He admitted the offence, and said that this man was the leader of a gang of men who had been persecuting him for years. Because of this persecution he could not get a decent job and had become one of life's failures. When asked how these men persecuted him, he said that one of their favourite methods was to libel him in the press so that his potential employers would read about him and refuse to give him work. On one occasion he rushed up to me in a state of great excitement, with a newspaper in his hand. On one page there were photographs of the King and of a well-known comedian. This he interpreted as a reference to himself—the comedian represented himself, and implied that he was a fool, and the King's photograph represented "His Majesty's pleasure." He believed that the photograph had been inserted at the instigation of his persecutors.

Although the patient had only an elementary school education he had acquired a good command of English. At my request he wrote out his story in full, and the following extract will show that he had developed a fluent journalistic style: "The postcards were simply a fair retort—there is no guilt on my conscience but a great deal on the conscience of G—. He was my employer for nearly three years. You will see the part played by G—in the vendetta which has strangely enough landed me here. No more now—perhaps later when I am feeling legato."

It is difficult to imagine a more disastrous and pitiful history than the one given by this patient. A young, ambitious Scotsman devotes four years to becoming a skilled artisan. On the eve of his career he is balked by a physical affliction which renders his training completely useless. He then spends another four years training himself for a totally different work requiring no manual dexterity, and at great personal sacrifice. Again his career is wrecked by a physical disability. At the age of 25 he is not only unfit for almost any kind of employment but is also, by his deafness, largely excluded from ordinary social intercourse. He was condemned to spend the rest of his life as a semi-parasite upon society, and his pride and self-respect were shattered. Persecutory delusions offered a way of escape from an intolerable reality.

The second case, which I saw in Holloway Prison during the war, is one of uttering threats. This is also a typical paranoid crime, and for the same reasons as apply in the case of criminal libel, a crime to which it is closely akin. In this case also the subject was in an intolerable situation from which there was no escape.

CASE 2.—A woman, aged 30, an Indian, was charged with uttering threats and was remanded to prison for a psychiatric examination. The circumstances of the offence were that she had several times threatened violence to a man who was lodging in the same house, and had finally bought a horsewhip which she carried with her wherever she went in the hope of meeting him.

Two years previously she had been convicted of assaulting a policeman and had served one year's imprisonment.

When first examined she was hostile, aggressive and intensely paranoid, and her conversation consisted of an unending story of British persecution of the Indian peoples. She was an educated woman and spoke perfect English. She was not hallucinated but had numerous ideas of reference, and even her remand to prison

for a medical report was interpreted as part of the persecution. A diary was found on her, and the following are typical extracts:

"India has a wage of £2 a year per head.
England has a wage of £500 a week per head.
Robbery, isn't it?
Curse, God's curse on this Devil's Island."

Of a visit to Madam Tussaud's she wrote:

"Better actors and actresses than the English were put into the background of English characters. Anna Neagle was made to look far better than she really is, and is shown as Queen of all the stars, placed right in the middle of the front row; Marlene Dietrich, most famous and most beautiful film star of the time is placed in the background. Everywhere you go you find these English are just like a pack of monkeys or a herd of wolves.

"This race wants wiping out of the face of the earth. My curse upon them and the curses of thousands of millions fall heavily upon them. God's great hand has spread heavily against them—His justice will prevail. He alone will punish them. It is beyond one's patience. Curse, curse, curse."

It was with some difficulty that the patient's personal history was obtained, but eventually she gave the following account of her past life. She was born in India in 1910, and was of pure Indian extraction. She was educated at Lucknow College until the age of 18 and qualified as a teacher. In 1933 she married an English soldier and lived happily with him in India until 1930, when she followed him to England and lived in the married quarters of a garrison town. From that point her story was one of unending petty persecution. The other soldiers' wives despised and abused her, and her husband began to drink heavily, and finally to illtreat her. In 1930 she was granted a separation order and an allowance of 18s. a week, and since then had lived alone in cheap lodgings. There were no children. When questioned about the offence with which she was charged she said that a man lodging in the same house had insulted and threatened her, and that she had bought the horse-whip in order to protect herself. The reason she gave for assaulting the policeman was that he had told her husband that he should not have married an Indian.

It requires little imagination to fill in the gaps in her story and to realize the strength of the external factors in this case. A sensitive, educated and intelligent Indian woman marries an English soldier in India and lives happily with him for three years, no doubt enjoying and identifying herself with the artificial glory which invested even a humble member of the ruling race. She then follows him to England and finds that she is merely the despised coloured wife of a soldier who is considered to have disgraced himself by marrying her. We may imagine that the attitude of the other soldiers' wives towards her was not one of tolerance and friendliness, and the fact that she was an educated and sensitive woman would act as a further incentive to the malicious. We know nothing about her husband, but he may well have been a decent man who, goaded by the incessant pinpricks of his friends and the early paranoid nagging of his wife, eventually turned his thwarted aggressiveness against her. Finally, by the outbreak of war, she is prevented even from returning to her own country.

In this case I do not think we need assume that there was a morbid constitutional factor at the root of her psychosis, although the type of reaction was no doubt determined by her temperament. She was trapped in an environment which would have been intolerable not merely to the inflated pride of a paranoid but to the self-respect of a normal person, and paranoia was her only way of escape.

The last two cases are of murder committed by paranoiacs, and I think they are worth describing because they illustrate the influence of an adverse sexual environment.

One of the striking features of paranoid crime is that although sexual delusions are common, sexual offences are very rare. The crimes attributable to delusional jealousy are almost always of a homicidal nature, and the amorous paranoiac, although he may pester the lady of his choice in all manner of ways,

very rarely commits a sexual assault. In East's 66 cases of paranoid crime no prisoner was directly charged with a sexual offence. It is often said that the paranoiac is sexually weak, and Bleuler found a "peculiarly weak sexuality" in all his persecuted paranoiac patients. But it is probable, I think, that the paranoiac is sexually weak only because he has made himself so—he has inhibited his sexual energy so that he can use it for ego purposes. He may or may not have inhibited it completely, but he has certainly learned a good deal about his sex impulses in his attempts to conquer them and so can readily see them in others. It is after the failure of his attempt to suppress sex that sexual delusions are likely to arise in his efforts to project the scorn and contempt which he feels for himself because of this failure. Sexual delusions therefore sometimes first appear after marriage, in the form of delusions of infidelity and sexual viciousness on the part of the spouse, and may culminate in a homicidal attempt. But occasionally the sexual situation which arises after marriage is a very disagreeable one, as in the following two cases. In these two cases of murder committed by paranoiacs the psychosis was associated with a very unpleasant sexual environment, but in contrast with the preceding cases the patients' difficulties were not insuperable—they could have been ended by resolute action. Moreover in both these cases there was stronger evidence of constitutional taint. Nevertheless the external situations were so unpleasant as to warrant the assumption that they played an important part in the development of the psychosis.

CASE 3.—A man, aged 30, murdered his daughter, a baby aged 22 months, by throttling. He was found guilty but insane.

A maternal aunt and uncle were in mental hospitals.

The patient gave the following history: He had the usual elementary education and then worked as a dock-labourer. Eventually he became a marine foreman and worked on board ships for short voyages. He married at the age of 22, and a son was born two months later. The marriage was happy for about four years until, as he said, he discovered that his wife had committed incest with her father both before and after marriage. As a result of this discovery he separated from her for 18 months, but a reconciliation then took place and they lived happily together for another two years. During this time he was unemployed and they lived on the dole: he did not try very hard to get work as he had saved a little money and thought he might as well enjoy it. When his money was exhausted he found work in a ship and was away on a voyage for a fortnight. He returned home one night and found his wife looking ill and haggard. The next day he left on another fourteen days' voyage. On his return he was horrified by his wife's condition—she was haggard in appearance, had lost three stones in weight, and smelled of semen. He came to the conclusion that she must have been debauched by a number of men, because one man alone could not have caused so great a harm, and he suspected that his sister's husband was the leader of this gang of men. He taxed his wife with visiting brothels in his absence and did not believe her denials. Because of her condition he insisted on her entering a hospital, but when he visited her there he tasted semen on her lips. He then heard that the doctors had been treating her in a private room and realized that they too had been debauching her. He therefore took her out of hospital on his own responsibility. Finally he realized that she must have been leading a life of debauchery for a long time, and came to the conclusion that his wife's younger child, aged 22 months, was probably the daughter of his sister's husband. He thought that any child having such a father would be better dead, and one night, after nursing the child in his arms, he throttled her. He denied that he had ever threatened to kill his wife or his sister's husband, although evidence was given to this effect.

When first examined this case appeared to be a straightforward one of delusional

jealousy, and all the patient's sexual ideas were regarded as delusional. The patient stated that his wife had admitted to incestuous relations with her father, but such alleged confessions by the spouse are frequently quoted by patients with delusional jealousy. In such a case it is usually found either that the patient has put a false interpretation on some trivial remark or, more commonly, that the alleged confession was the result of persistent accusations, threats of violence, or even actual assault. In this case, however, the explanation was very different, for when the police and other reports were received it was found that the wife had admitted to the police the incestuous relations with her father before marriage and had said, in answer to a question, that she "thought" her husband was the father of her two children.

In the following case the sexual situation which confronted the patient after marriage was even more unpleasant.

CASE 4.—A man, aged 33, murdered his wife by battering her head with a hammer. He was found guilty but insane.

The patient denied any familial taint, but the police report contained the following information: "All the family are of inferior intellect, and the elder brother and sister appear to be morally weak. The sister appeared in a case of carnal knowledge at the age of 12 years. Nothing is known against either parent."

The patient gave the following history: He had the usual elementary education, and at the age of 17 joined the army. He served in India for ten years and was then discharged. In India he had one attack of malaria, and in 1924 he had a soft chancre. He had not suffered from syphilis, and repeated serological tests were negative. After his discharge from the army he worked as a railway porter and was so employed at the time of the crime.

In 1932 he became intimate with a woman friend of his sister, and within a fortnight of his first meeting the woman he married her because she told him that she was pregnant. A daughter was born seven months after the marriage—the patient said that it must have been premature and appeared to have no doubt that he was the father. After the marriage he and his wife lived in two rooms, and his sister came to live with them and slept in the same bedroom. His wife, he said, would not permit him to have normal sexual relations with her, and the only occasion on which he had normal intercourse with her was once before marriage. She practised a number of perversions on him, however, and would relieve him by means of masturbation and fellatio. After so doing she would get into bed with his sister, and he often awoke during the night to hear them indulging in amorous exchanges.

According to the patient this sort of life went on for two or three years, and although he tried to turn his sister out of the house his wife objected, and she always returned. Eventually he came to the conclusion that his wife must be suffering from some strange disease and that she had infected him and his sister. He believed that this disease was due to a "cancer-consumption" germ, and that she had purposely infected him because she wished him to die. He also believed that his wife's parents were suffering from the same disease and, in addition to his wife's alleged sexual perversion, he gave the following reasons for his belief:

1. His wife had insured him for a small sum immediately after marriage.
2. A young man who had been friendly with his wife before marriage died suddenly.
3. A child who lived in the same house as his wife's parents suffered from fits.
4. For several months before the crime his food had had a queer taste, and for a few weeks before the crime he had suffered from a pain in the chest and an unpleasant taste in the mouth.

Finally his daughter, then aged $3\frac{1}{2}$ years, said to him one morning, "Mammy hurt me." For some time he had suspected that his wife had been interfering sexually with her daughter, but until then he had had no proof. When the child said this to him he "lost his head" and killed his wife with a hammer. He then put on his best suit, told his brother what had happened, and surrendered to the police.

At first it was thought that the whole of the patient's story was part of a complex delusional system, but after reading the reports on the case one's opinion had to be

considerably modified. The patient's sister, on oath, made the following statement: "I got on well with the deceased. I was more than friendly—I loved her. My brother and his wife were not living together as man and wife—they occupied different beds. I slept with my sister-in-law. He asked why I did not break with my sister-in-law and take some boy friends. I said I did not take any interest in boys—I told him that she loved me and I loved her. On September 5 I went to — Road at 2.30 p.m. and went to bed with her until 4 p.m. Accused came in at 5 p.m. I thanked him for giving her back to me." This sister also told one of the medical witnesses that when the patient got up in the morning he would strip, "walk about, and wave his penis." The police surgeon who examined the little girl found no signs of any interference, but stated that when he commenced to examine her she "lay back, smiled, and opened her legs as though in expectation of pleasure."

The patient settled down quite well and soon appeared to lose his delusions. He was too quiet and seclusive, however, and his expression was always rather morose and furtive. About six months after admission I had a long talk with him. At first he said that he was quite well and had lost all his "silly ideas," but eventually he told me that he knew that he was still affected by the "cancer-consumption" germ. He said that he had remembered that his wife used to walk about muttering "Eight and three, eight and three." At the time he did not know what she meant, but he now realized that she meant that she had killed eight men and that three more were to die. He knew that he would be one of the three.

It is not difficult to understand why paranoid delusions developed in this case. A weak-willed man marries an almost incredibly vicious woman and, instead of taking determined action from the beginning, he allows himself to drift into a state of extreme sexual depravity. When this situation has arisen paranoia offers his only way of escape without admitting to himself his own humiliating moral failure. It will be noted that his delusions take the one form that will free him from all blame—he believes that his wife is diseased and that she has infected him, and thus he becomes, not her acquiescent partner, but her victim. But even this comforting paranoia will not excuse him for permitting the defiling of a young child, so that in the end he is driven to violent action.

These two cases illustrate another important point—that in cases of paranoia no statements should be regarded as delusional merely because they are very improbable. Both cases were first examined before the writer had seen the police records, and sexual delusions are so typical of the homicidal paranoiac that one's first impression was that the whole of the patients' statements on sexual matters were delusional. Later many of their statements were found to be true, but I think it probable that if these cases had not been subjected to police investigation much of the truth might have remained hidden. In the histories as given by the patients, fact and fancy were so closely connected that it would have been easy to regard the whole of the stories of sexual degradation as delusional, and in ordinary circumstances it is not likely that the relatives concerned would have confirmed any of the patients' statements. The whole truth was elicited, I think, only as a result of the very careful police inquiries which are made in cases of murder. I have received similar surprises in other criminal cases. On one occasion I examined a paraphrenic woman charged with stealing money. Acquisitive crime is not uncommon in paranoiacs and usually takes the form of fraud, with a denial of any ill-intent, the subject having misappropriated other people's money to further his grandiose delusional schemes. This was such a case, and the woman was obviously psychotic with numerous delusions and hallucinations. Among other things she told me that she was under the guidance and protection of a mysterious woman arrayed in a blue cloak and a peculiar headdress, with a swastika on her forehead and the signs of the Zodiac around her wrists. I reported her insane, attended Court and intended to give prominence to this mysterious figure in my evidence. To my astonishment the first witness called by the defence, who were trying for a full acquittal, was dressed exactly as had been described to me by my patient. I was very glad on that occasion that medical evidence is usually taken last, and that an expert witness is allowed to be in Court throughout the trial and hear evidence as to fact. After two or three similar, though less startling surprises one became almost obsessively meticulous when examining paranoiacs, and would hesitate before rejecting a patient's claim to be of royal or even of divine origin.

To return to the subject after this digression I believe that in certain cases of criminal paranoia the subject has had grave external as well as internal difficulties, and that occasionally criminal paranoia may be regarded as a logical and almost inevitable reaction to an unbearable and inescapable environment. I also think that the part played by the external situation is more clearly shown in criminal than in non-criminal paranoia, although I have had less experience of the latter condition. If this be a fact, it may conceivably be due to two reasons. It may be that paranoia which is based upon a real and intolerable predicament is more likely to give rise to desperate action, and it may also be that in serious criminal cases the whole truth is more likely to be discovered than in non-criminal cases. In paranoia the truth is sometimes almost as strange as the delusional fiction.

THE PSYCHIATRIC ASPECTS OF TROPICAL SERVICE IN THE NAVY.

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THE following article is derived from a preliminary report made by the writer while attached to the Habitability Sub-Committee of the Royal Naval Personnel Research Committee of the Medical Research Council. The observations were made in India and Ceylon during 1945.

FEATURES OF TROPICAL SERVICE.

General factors. Adaptation to life in the Tropics involves a multitude of factors. A special situation exists in adaptation to India. This was observed mainly in shore-based staff at a northern port.

Frustration was the chief element found. All instructions had to be given to staff whose grasp of English was imperfect, who either failed to understand and required repetition, or pretended to grasp it and did the wrong thing. Telephoning was slow and replies unintelligible and often irresponsible. Correspondence was equally slow and bad. As a result the man with a drive for efficiency found himself battling against an amorphous intangible obstruction. In Service Departments there was a great deal of overlapping and interlocking, and it was difficult to achieve positive decision and action quickly.

For the man whose interests had been cultural there was a lack of intelligent society, or of the resources of a European capital or city. The man of humanitarian or liberal ideas found himself in a society in which the sores were unconcealed and poverty and disease widespread. He was forced to take up an attitude either of ignoring the deformed beggar (whose habits are disgusting), or taking upon himself a sense of responsibility for his fellow men, crushing for one without strong convictions.

Disgust was a potent source of stress. Insects of gross and unseemly build were liable to infest his cupboards, bugs were democratic in their distribution. The glare of the sun on dusty places revealed decay that in a kindlier clime is clothed or hidden by vegetation. Naso-pharyngeal hygiene is dealt with differently east of Suez from the usage that obtains at home, and the light sleeper was liable to be waked before sunrise by the raucous hawking and spitting, presumably of the servants who were later to attend his wants.

Standards and sets of values particularly appeared to be challenged by life in India. The man from the United Kingdom, whatever the shifting standards and values, religious and ethical, of this twentieth century, had lived in a

community in which behaviour was, on the whole, stabilized and consistent. In India the incoming European overflowed the minor social castes and groupings traditional to English India, and was in a community in which he had to decide his own standard. His colleagues abandoned, in many cases, even the pretences that convention maintains at home. If he lacked principles founded on an established philosophy he was bewildered and lost. An unexpected result was reported by chaplains who found themselves haunted vaguely by the type of man who at home would never condescend to visit them.

Finally, emotions appeared to get out of hand in the absence of familiar tracks. Courses of action were embarked upon that later added much perplexity to the life of the man who had little experience of handling complications, and lacked the attitude that would have allowed him to carry them through.

Adaptation in the European established in India appeared to have involved his isolating himself in his own family or group of friends, and the new arrival met more the defences of the other Europeans than obvious goodwill. Even in Service clubs and establishments this lack of outgoing was apparent, comparing unfavourably with the welcome a new arrival obtained in any Service Establishment at home.

For the rating, lack of amenities ashore, the absence of women of his own kind with whom he could associate, and the continued feeling that he was being exploited, added to his stresses. Leave camps were few, mainly Army, and not always attractive. Beer, with its social implications, was in short supply: even in large ports, cinemas and drinking saloons formed the expensive alternatives for an evening ashore, with the doubtful attractions of a native brothel, and a probable "dose" to follow. In more isolated bases or stations monotony and lack of external stimulus tended to promote apathy or exasperation.

In the Service, leave in India was an expensive undertaking, requiring considerable organization ahead. Busy men found it easier to do without. Less active men often considered it not worth while. On leave one was still in India. There appeared to be a tradition of much less leave, and a tendency to feel that it should be sought only in special circumstances or on medical advice.

Individual aspects.—Individual factors have been assessed from analysis of one hundred psychiatric cases. Of these one-third was obtained in India and was mainly from shore bases and transit camps: two-thirds of the material was obtained in Ceylon, and there the majority of the cases were direct from ships and had recently been at sea.

Age was highly significant. An unduly high proportion of the breakdowns occurred in men over forty. Men under twenty-five appeared to show the fewest breakdowns, taking into account the probability that they were the most numerous group. In the age-group twenty-five to thirty-five, factors such as increased length of service, or marital and home responsibilities, were liable to be increasingly important, but apart from their additional stress this age-group appeared to adapt equally well.

Marital state was of great importance. Army findings were that in 25 per cent. of cases of breakdown home problems are a factor. My own findings in Naval personnel were almost exactly parallel. Several observers point out,

however, that the happily married man, uprooted and sent overseas, is often as deeply shaken as the man possessed of home troubles.

Length of service overseas showed a close correspondence with psychiatric casualties. In the first six months a peak of cases, presumably due to the weeding out of men who failed to make the initial adaptation, was shown. Between six months and eighteen months of overseas service there was a drop in the number of cases, and then a sharp rise occurred, which fell after the two-year period. This fall can be accounted for by the small number of men with over two years' service. This corresponds with the opinion of observers that the efficiency of men tended to drop after eighteen months overseas' service. Stress was laid on the fact that after two years it became vital for a man to know when he might expect to return home.

Taken in relation to the total period of life in the Service, the maximum number of cases occurred between the second and third year, and again after the fifth year. It was assumed that the first group contained men who had come overseas in their first year of service, and who had succumbed after another eighteen months; and that the second group had already borne the brunt of the war, and might be undergoing a second period of overseas service. This occurred frequently with ratings permanently in the Service.

In respect of personality qualities it may be said generally that the threshold for breakdown on tropical service was much lower. The lower grade intelligence found adaptation difficult: the temperamentally unstable reacted excessively and became a sick man: the man who had had previous nervous symptoms relapsed: even the stable man with personal problems with which he had been able to deal, or previous stress of action that he had met without symptom, developed anxiety reactions after an uneventful term in the tropics. The dreamy escapist found his retreat cut off, and succumbed to a depressive state. Sexual problems bulked much larger in the absence of other elements of life. The psychopath, too, whose retention in the Service and foreign draft had been dictated by motives other than good sense, revenged himself nobly by creating an insuperable problem for ship's company, shore establishment, hospital, and eventually psychiatrist.

There was little opportunity to study at first hand life in ships in the tropics. The essential feature peculiar to tropical service is the hot and humid condition that obtains in working and living spaces. Other features were duplicated in spheres of isolated or foreign service other than in the tropics. A false attitude was developed in relation to the factor of heat. It was asserted that as being most obvious it was unjustly blamed when other burdens of life oppressed or irritated. The truth is that it was as a result of the heat that the individual's capacity for meeting other external demands was diminished.

In the group of one hundred psychiatric cases analyzed, an attempt was made to assess the factor of heat in cases seen by the psychiatrist. An absolute criterion for this to be established was difficult. In general, debility, minor skin rashes, tropical pemphigus, etc., were regarded as physical evidence of stress from heat. Such evidences, together with a genuine awareness of the burden of the heat, were taken as constituting a reaction to the heat. An interesting difference emerged between the group of cases, mainly shore-based,

seen in India, and those seen in Ceylon, who were chiefly referred from ships. In only 10 per cent. of the cases seen in India was heat a factor in the breakdown, while in those seen in Ceylon 48 per cent. of the casualties showed, in greater or lesser degree, reactions to heat. This did not include cases of heat exhaustion, or gross skin lesions which did not come under psychiatric observation.

CLINICAL ASPECTS.

Certain characteristic observations are made by all those who come to work under tropical conditions. Information regarding such adaptation is most readily obtained from those who have been from three to six months out; they are still alive to the changes in themselves. Primarily there is a sense of lassitude, tiredness and awareness of the temperature. This is relatively quickly accepted, and the only change in the individual's effectiveness observed is a somewhat lower tempo of performance, and a need to accept slightly lower standards in himself and others. It is generally agreed, however, that with work and interests the effects are at first not markedly significant, and a good performance and healthy outlook are maintained, with two exceptions: immediate memory and capacity for concentration are impaired. To quote a Technical Officer six months out, "You can't remember a name or a telephone number." "You have to sit back and think; you do on paper a calculation that you should do in your head, and you find that laborious and difficult and make silly errors." An officer out a year invites a guest to lunch, hurries through his morning's work to arrive ahead of his guest and, having succeeded, finishes lunch, forgetting the guest. This is a failure of immediate retention. It is fluctuating, and as far as can be observed appears to have a direct relation to the temperature, worse in the hot hours of the afternoon and absent in the evenings, disappearing gradually with a change to a cooler climate. Further, it is relatively independent of personality, though more obvious in the less methodical or those who have to deal with much detail. Everything suggests that it is metabolically determined and not emotional in its origin. A secondary phenomenon is the emergence of anxiety, psychic and somatic, if the need for continuous concentrated intellectual work is imposed on one. Then results a feeling of tension and apprehension, with definite tremor. Similar observations were made in the hot room at Cambridge, where subjects not infrequently complained of apprehension and epigastric discomforts when they had completed a test demanding concentration and attention under conditions of heat. It is an important phenomenon, and both the failure of retention and the subsequent anxiety require further observation.

A social consequence of the impaired retention and anxiety, possibly more primarily determined too, was irritability. This was, in fact, of considerable importance, particularly in officers, as excessive irritability in the head of a section was distributed in geometric progression through the whole unit.

A more established "sea-change" was noted in the men who had been at sea in the tropics for a year or more. An observant C.P.O. stoker from a destroyer and a P.O. stoker from a submarine dealt with this in most detail: "A man becomes dreamy, does not put his mind to his job, is irritable with his

friends, hates the sight of his messmates, pays no attention to what is said to him, and keeps to himself. You can see the whole of a watch going ashore and separating." "The men are irritable, keep to themselves, don't want to go ashore, feel no one takes an interest in them, and are resentful. A fight does a lot of good and clears the air."

It is in such a background that psychiatric case material is found, and certain broad observations at once emerged.

Psychotic reactions were beyond comparison very much more frequent than was the case at home or in non-tropical service. Even the milder cases are frequently mildly psychotic rather than psychoneurotic, or showing simple biological reactions. Out of the total cases, numbering in all 135, in the writer's care in the Combined Services Hospital in the four months from May to September, 1945, one in seven was a psychotic. The criterion taken was "certifiable by British law," and was exclusive of unstable psychopaths, defectives and cases of depression with mild ideas of reference. Of the naval psychiatric cases invalided through Poona and R.N.A.H. Bombay in six months, from October, 1944, to March, 1945, every fourth case was a frank psychotic. An army psychiatrist, through whose hospital psychiatric cases from the three services passed, stated that this high proportion of psychotic reactions was peculiar to naval cases, and did not occur in the other services. Nor is it the case in the Navy in temperate climates, where, in the writer's experience, a psychosis is a rarity.

At first the actual case material presented appeared strictly comparable to that found in home stations: mentally backward, temperamentally unstable, with reactions to war stress. After a few months, however, difference of emphasis became apparent, and in cases from ships a shadowy syndrome began to form itself.

Most frequently, referral was on the initiative of the P.O. Sick Berth Steward or Executive Officer who had observed failure of efficiency, undue irritability or seclusiveness, peculiar behaviour or, not infrequently, a fight or quarrel in the mess-deck.

The patient when first seen had often a faintly mask-like expression and muddy complexion reminiscent of the anaesthetized. Eyes were slightly prominent and thyroid full; the lips were tremulous and the hand shaky. There was an increase of superficial or tendon reflexes and moderate tachycardia.

At first dull and apathetic, the patient might show a certain hostility and unwillingness to confide, but with increasing confidence the most common complaint was depression and difficulty in thinking. "Je ne peux pas rassembler les idées" says the French rating. Most commonly in the milder cases conscious anxiety was present, focused on specific fears—that he had tuberculosis or syphilis, was "going round the bend," or was suffering from peculiar after-effects from a cigarette given to him by an Indian weeks before; or the normal somatic manifestations of pounding heart or blurred vision were complained of. Not infrequently, too, war-dreams or nightmares and acute anxiety attacks occurred in the individual who had made no such complaint during the period of stress, in temperate waters. But the same patient

proceeded in an astonishingly high proportion of cases to reveal the conviction that others disliked him, talked about him and laughed at him, or were making special signs about him, usually on the basis of some sexual indiscretion or anomaly of behaviour of which his messmates could have had no knowledge. In cases slightly more severe, but not essentially different, more bizarre thought content was found. In the case of one man noticed to be muttering to himself and behaving peculiarly, there was revealed a vivid phantasy life round the person of an actress recently seen in "Blithe Spirit." For hours he would imagine himself in scenes from the play and be oblivious to his surroundings. In another there was a depressive preoccupation with the belief that his fellows regarded him as a homosexual; in another, a sudden conviction that a companion in the same ship was about to fling acid over him resulted in a furious attack. A further similar case revealed vague perverted preoccupation with flogging, unexpectedly put into practice with a heavy army belt on the person of a Sick Berth Attendant bending over an adjacent bed. Another was found gazing at his outstretched hands and confessed to an impulse to slash open the backs with a knife or razor.

Failure of the intellectual faculties, disorientation or hallucinosis was not a feature of such cases.

The earlier history obtained in such cases was by no means that of an unstable individual; and there was often a good work record and several years of service life and stress in earlier phases of the war. With one exception, the cases on which this description was based have been admitted from ships. A depot ship, in which living conditions are particularly bad in respect to temperature and humidity, which had not moved for over a year, contributed four cases.

Admitted to hospital, the usual progress was towards recovery. The clinical picture clarified towards frank depression or anxiety state, but in several a schizophrenic illness supervened.

Cases of established psychosis were, as has been stated, frequent. In several of them a history of "pre-psychotic" phase similar to those described was elicited. Schizophrenias occurred, but manic excitements with over-activity, flight of thought, and facile anger in a clear consciousness, preponderated among psychotic admissions. Classical depressions were much more rare. Two toxic-exhaustive psychoses with disorientation and hallucinosis were seen; one followed a minor surgical operation, and the other was sequel to malaria.

Mepacrine intoxication may have been a factor in certain of the acute excitements who were transferred from other areas of operation and who arrived with typical pigmentation and little history, but it was not administered as a routine in the base from which most of the cases described were derived.

SUMMARY.

Observations have been made on the factors of stress operating on Naval personnel based in India and Ceylon, and working under tropical conditions. A clinical description has been given of the case material. These observations

are based almost entirely on the experience of the psychiatrist dealing with men who have broken down. Figures are quoted only in so far as they offer objective demonstration of such facts as are known to every executive and medical officer operating in these areas, but which tend to elude objective demonstration.

While a psychiatric survey must deal with the whole picture, an attempt has been made to underline the elements particularly related to the effects of heat and humidity, and to suggest possible lines of investigation.

The first element of importance appears to be that associated with "tropical loss of memory." This, it is considered, is largely a metabolic phenomenon, and not primarily emotionally determined. It is a field for investigation biochemically and by psychological tests. Somatic and emotional tension is considered to result from an effort to overcome the interference with mental activity that is produced metabolically. Emotional imbalances and complex stresses may eventually manifest themselves clinically in this situation in personalities hitherto capable of dealing with them.

A "pre-psychotic tropical syndrome" is described. This differs materially from the conditions that have been met with in men who experienced equal isolation and corresponding stress in non-tropical overseas service. A high proportion of breakdowns in naval ratings on tropical service are psychotic in character. This is not the case in naval service in temperate climes, however arduous. It is said not to occur in other services in the tropics.

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PUPILLARY PHENOMENA ON APPLICATION OF A STRONG CONSTANT ELECTRIC CURRENT AS USED IN ELECTRONARCOTIC TREATMENT.

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IN the usual procedure of electronarcotic treatment, the electrodes are placed bitemporally and an initial electric current of 180 m.a. is applied for 30 seconds. During this period a tonic extension of the skeletal muscles occurs, accompanied by strong contraction of the pupils, which in the majority of cases are reduced to pin-point size. Slight convergence of the eyes may accompany the contraction. The contraction relaxes somewhat when clonus ensues, but usually becomes slightly more marked in the following stage when the electric current applied is between 60 and 80 m.a.

This pupillary contraction is in contrast to the pupillary dilatation observed in the tonic-clonic stage of electric shock treatment. In electroshock, an electric current of very short duration is applied to produce an epileptiform fit, whilst in electronarcosis the skull is submitted to a strong constant electric current. The eye signs in shock treatment are part of the convulsive mechanism, whereas in electronarcosis the possibility of stimulation of central and peripheral parts must be considered.

Pupillary contraction has been elicited in animal experiments by stimulation of the occipital lobe; this area is too far away from the site of stimulation to be considered in our observations. In the human subject no constricting effect upon the pupils could be produced by direct electric stimulation of any cortical area (Foerster, 1936; Penfield and Erickson, 1941). It is unlikely, considering the site of the electrodes, that the pupillary phenomena are due to stimulation of subcortical oculomotor centres; moreover, upon placing one electrode on more occipital parts of the skull the contraction of the pupil on this side failed to take place. This finding strongly suggests that the pupillary response is produced by local stimulation of the peripheral tissue.

There are three pathways by which the pupillary size might have been influenced: reflexly through the trigeminal nerve or the optic nerve; directly through the oculomotor nerve. As the pupillary contraction did not occur when one electrode was placed more occipitally but still in the distribution area of the trigeminus, a trigeminal reflex can be excluded. For the same reason an optic reflex is improbable. Because of the partial crossing of the optic fibres, if stimulation of the optic nerve should lead to reflex contraction, one would expect a contraction in both eyes wherever the second electrode is placed. There remains to be considered direct stimulation of the oculomotor nerve; there is no fact in the experimental conditions which would contradict

this assumption. It is therefore interesting to note that amongst the oculomotor fibres the pupillo-constrictory are the most responsive to electric stimulation.

In further examination one eye was, before treatment, atropinized so that no contraction of the pupils to light nor to convergence could be elicited. It was then found during application of the electric current that whilst the pupil of the untreated eye contracted as usual, a dilatation of the atropinized pupil occurred. This result would be open to controversy but for the experimental findings of Kunz and Richins (1946). These authors, experimenting on cats and dogs, stimulated the oculomotor nerve with faradic current, with the result that contraction of the pupils occurred. When they had atropinized one eye and then applied the stimulus, the pupil of this eye dilated still further whilst the other pupil contracted as before. The dilatation of the pupil occurred in their experiments only when the atropinization had been complete, and the stimulus required was appreciably greater than that which elicited constriction.

They conclude from these experiments that two separate neurones reach the sphincter muscle of the eye *via* the oculomotor nerve, a cholinergic, whose stimulation causes the sphincter to contract, and an adrenergic and inhibitory, which when stimulated causes the sphincter to relax. The findings of these authors in animal experiments are therefore identical with our own observations in humans.

In the past it has been the accepted view that the pupillary reflex mechanism is regulated by the parasympathetic and sympathetic system, by an antagonistic inhibitory activity of the two systems. Recent experimental work, however, has shown that the role of the sympathetic in the variability of pupillary size is of minor, if of any significance. Recording of the pupillary reactions after sectioning of the oculomotor nerve and the extirpation of the sympathetic proved that the parasympathetic is almost exclusively responsible for the pupillary reactions to painful stimuli, to emotional stimuli, and to the withdrawal of light (Ury and Gellhorn, 1939; Hodes, 1940; Seybold and Moore, 1940; Ury and Oldberg, 1940; Langworthy and Ortega, 1943; Gellhorn and Levin, 1945; Kunz and Richins, 1946). The experiments of Kunz and Richins, and our own observations, suggest that the regulation of the pupillary size in the midbrain, mediated by the oculomotor nerve, is actuated by two separate fibre systems, one whose degree of activity determines the intensity of sphincter contraction, the other which, when active, brings the sphincter to complete relaxation.

If this is correct we should find it expressed under physiological and pathological conditions.

The following observations were made on two patients both suffering from an anxiety state. They had in ordinary daylight a pupillary diameter of 5 and 6 mm. respectively, and reacted well to light. When in the dark the pupils enlarged to 7 and 8 mm. and the reaction to light was absent. There was no serological nor neurological abnormality in either case, and the cerebrospinal fluid of one was negative. Assuming two separate fibre systems arising from the oculomotor midbrain centre, then withdrawal of light may not only reflexly lower the activity of the constrictor fibres, but may also stimulate the

sphincter relaxing adrenergic fibres ; if this be so the light stimulus will find the constrictory fibres in a refractory state and no contraction of the pupils will occur. From the preceding it seems reasonable to assume that excess of adrenaline in the blood stream might be a factor which conditions the rigidity of the pupils under these circumstances. The mental state of the two patients would support this assumption. Failure of the pupils to react to light, without any organic process, has long been known in patients where emotional tension is in the foreground of the picture. This has been described in catatonic states and in the hysterical fit. In these conditions the underlying mechanism may be the same as in our two cases, with the difference that withdrawal of light is not an essential factor for the appearance of this phenomenon.

The existence of two specific neurones originating in the Westphal-Edinger nucleus would finally offer an explanation for the paradoxical enlargement of the pupils to light found occasionally in the Argyll Robertson pupil and in internal ophthalmoplegia ; the mechanism may be similar to that in the atropinized eye following oculomotor stimulation by electric current. Provided that the constrictor neurone is sufficiently inactive, failure of the pupils to react to light would increase the likelihood of the antagonistic adrenergic neurone being activated by the light stimulus and producing a pupillary dilatation.

SUMMARY.

In electronarcotic treatment when a galvanic current of 180 m.a. is used with the electrodes bitemporally placed, a strong contraction of the pupils takes place. This is found to be due to stimulation of the oculomotor nerve. On complete atropinization of one eye, the pupil of this eye dilated still further under the same conditions. The results are identical with those obtained by Kunz and Richins in animal experiments, and they suggest two separate neurones arising from the oculomotor midbrain centre conducted through the oculomotor nerve to the sphincter muscle of the iris ; the cholinergic determines by its intensity of discharge the intensity of sphincter contraction, the adrenergic actively relaxes the sphincter. Clinical phenomena which can be correlated to these findings are mentioned.

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THE NASOPALPEBRAL REFLEX: ITS APPLICATION TO NEURO-PSYCHIATRY, PARTICULARLY TO INSULIN SHOCK TREATMENT.

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THE subject of this contribution to the knowledge of reflexes is not the discovery of a new reflex or a new modification of an old one. On the contrary, the reflex at issue was described for the first time as far back as 1896 in the *Lancet* by W. Overend, who called it the "frontal reflex." As has often happened with many other reflexes, it was overlooked and rediscovered many times after, and each of the authors gave to it another name. However, in spite of all these numerous contributions its practical clinical value remained of no importance, and it is scarcely mentioned in text-books dealing with nervous disorders.

Stimulated by our investigations of the behaviour of reflexes in electrical shock procedure (1943), and by trying to compare and utilize these experiences in insulin coma, we came to realize that this apparently rather valueless phenomenon can be of great use not only in insulin treatment, but also in the investigations of other states of unconsciousness.

Overend, in his short preliminary note on a new cranial reflex, has given a correct description of the phenomenon. He said that a slight tap in the middle line of the forehead is followed by twitchings of the eyelids of both sides. Several years later the same reflex was rediscovered independently by McCarty (1901) as the "supraorbital reflex," and by Bechterew (1901) as the "eye reflex." Again, years later Guillain (1920) described the same reflex and called it the "nasopalpebral reflex." Shortly afterwards Simchowicz (1922), using the tip of the nose as the reflexogenous zone, added the name "nose-eye reflex." Wartenberg (1930) suggested first the name "glabella reflex," and later (1945) "orbicularis oculi reflex." He has rightly recognized that all these various names cover one and the same reflex phenomenon, consisting of a brisk contraction of both orbicularis oculi muscles in response to a short tap on a wide frontal area. This reflexogenous area is, in fact, spread from the tip of the nose to the hair borderline of the forehead, and laterally to a vertical line approximately through the external eye canthus. But there is no denying that the responsive *centre* of this vast field is the root of the nose.

The best method of elicitation is a quick tap with a small percussion hammer or even with the tip of a half-bent middle finger on the root of the nose or between the eyebrows. The easily discernible brisk contraction of the eyelids on both sides is an unfailing response in every healthy person even when the eyelids are closed. By a voluntary exertion a small percentage of persons can suppress the reaction, but this rare faculty, as we shall see, cannot influence

the clinical application of the reflex. The elicitation of the reflex in persons with eyelids closed and its invariable presence in blind persons eliminates the possibility that we are dealing here with an optico-palpebral blink reflex—a protective response caused by objects manipulated near the eye.

The nasopalpebral reflex has found only a very limited application in neuropsychiatry up to now. It is diminished or even abolished on the side of a peripheral facial palsy, and exaggerated in postencephalitic Parkinsonism. Only Simchowicz has mentioned in few words its abolition in three out of five cases of genuine epilepsy immediately after a seizure.

We can notice the particular susceptibility of the reflex in the E.C.T. procedure. It disappears regularly after the convulsive fit for a variable length of time related to the depth of the comatose state. But even a subconvulsive shock can suppress it for a short time.

One of the generally admitted difficulties in insulin coma treatment is the lack of an objective and reliable sign for the assessment of the progressive degrees of unconsciousness. Murray *et al.* (1938) defined as a moderate coma that stage in which the superficial reflexes are lost and a positive Babinski appears, although they have to admit that a positive Babinski occurs in most cases during the unconscious state, and its appearance in relation to a definite time or depth of the coma could not be confirmed. On the grounds of our own investigations we arrived at the same conclusion. The susceptibility to an extensor toe response is highly individual; in some persons it appears already in a superficial comatose condition; in others it is not evident even in a deep coma. In the popular table of Himwich *et al.* (1939), illustrating the sequence of events during hypoglycaemia, the depression of pyramidal functions is mentioned in the 4th hour and the loss of the corneal reflexes at the end of the 5th. Frostig (1940) makes the statement that "lid and corneal reflexes are the last of the reflex signs to disappear," and in his table it is noted that "lid and corneal reflexes are sluggish" in the 5th hour. What this author meant by "lid reflexes" is not evident, but from their obvious similarity in behaviour with the corneal reflex one can infer that they have nothing in common with the nasopalpebral reflex. He rightly remarks that "loss of consciousness is recorded when there is no reasonable response to touch and call," and adds, "This is certainly an inaccurate method." This unsatisfactory state is discussed and expressed in the well-known book by Kalinowsky and Hoch (1946), and they write, "There is unfortunately no agreement among insulin therapeutists as to the definition of coma."

Our observations relative to the nasopalpebral reflex, seem to show that there is no necessity for such a pessimistic opinion. With a sufficient dose of insulin a stage of unconsciousness can be achieved in the 3rd hour in which the nasopalpebral reflex invariably disappears. Parallel to this disappearance the patient becomes quieter, although myoclonisms and twitchings may still be present. Shortly before its total abolition in some persons a sluggishness of the response can be observed; in others, on the contrary, the reflex is exaggerated and the response extends over a much wider area than the eyelids, but eventually the reflex disappears abruptly and cannot again be elicited till the coma is terminated. From this so easily defined moment, which seems to

indicate the start of a deeper stage of coma, the unconsciousness grows deeper and deeper till the corneal reflex disappears. It is in the hands of the therapist to terminate the coma according to the requirements of the given case, reckoning from the moment of the disappearance of the naso-palpebral reflex. The assessment of the exact time at which the reflex disappears is at the same time a valuable guide for the direction of the required dose of insulin, which can be so manipulated that this reliable sign is achieved in the second half of the third hour. A great advantage is the simplicity of its elicitation, and the ease with which its presence or absence can be noticed.

Compared in time with the appearance of the Babinski sign it can be said that the extensor response is established, as a rule, prior to the abolition of the nasopalpebral reflex, but the exact time relationship is impossible to define, since the Babinski sign is individually highly variable as to the time of its appearance and to the character of its features.

We did not extend our observations so long as to the disappearance of the corneal reflex, but found it occasionally still present, though sluggish, at the end of the 5th hour. Its disappearance is no doubt a warning signal for the termination of the coma, but useless as a sign for the therapeutically required demarcations.

The presence or absence of the nasopalpebral reflex is a good measure of the intensity of any spontaneously developed fainting or comatose state. We have observed in progressive comatose conditions all the stages of gradation in the same attack, starting with unresponsiveness to call, appearance of the Babinski sign, abolition of the nasopalpebral reflex, and finally the disappearance of the corneal reflex.

In spontaneous epileptic seizures the intensity of the fit can be gauged by the duration of the absence of the reflex after the attack.

In anaesthesia its presence is a good controlling sign for the relatively harmless degree of lost consciousness.

The behaviour of the nasopalpebral reflex in sleep is of particular physiological interest. In the majority of sleeping persons the reflex could be as readily observed as in waking persons, but in a small proportion, who have shown other signs of a deep physiological sleep, no response could be obtained.

In psychotic stuporose conditions it never disappears, and it can be presumed that psychogenic fainting or convulsive attack will not bring forth its abolition. Our case material is not suitable for such investigations, and it has still to be left open to proof.

DISCUSSION.

The position of the nasopalpebral reflex within the classification of reflexes has been widely discussed, but the authors, not being aware of its peculiar behaviour in states of disturbed consciousness, especially in such states as can be artificially produced and have therefore the advantage of an exact experiment, have not possessed sufficient data for a comparable study of this phenomenon in the same individual, at the same time and the same neuro-psychic condition.

The majority of workers were inclined to regard this reflex as an indirect response identical with skin reflexes, or at least with indirect periosteal, cartilaginous and osseous responses of isolated or combined character. Recently Wartenberg in his book on reflexes, after discussing this question elaborately, came to the conclusion that this phenomenon is a direct stretch reflex of the orbicularis oculi muscle, and consequently should be called the orbicularis oculi reflex. Our observations cannot bear out this opinion. The response can be obtained from a wide frontal field as far remote from the orbicularis muscle as the tip of the nose or the frontal hair border. On the other hand, a tap on the lateral sector of the orbicularis outside the external canthus is commonly without effect, although in the same person a good response from the root of the nose can be easily obtained. The reflex is highly susceptible to abnormal states of consciousness—a behaviour not observed in muscle stretch reflexes. In the electrically-produced shock condition, or in insulin coma, it behaves like a superficial or indirect reflex, whereas at the same time the muscle stretch reflexes are not only well preserved, but even exaggerated. And lastly Sommer (1938), in his exact experimental investigations, could not find action currents by brisk stretching of the orbicularis oculi muscle. He, too, points to the fact that muscle spindles—the receptive end-organs for the direct stretch reflex—are absent in all expressive muscles of the face. Although the similarity of its behaviour to that of the superficial indirect reflexes cannot be denied, it would be nevertheless incorrect to identify this phenomenon with a single skin reflex. It is true that with a quick stroke along the ridge of the nose with a match a similar reflex eye twinkle can be occasionally elicited, but this response is often absent in a person with a vivid nasopalpebral reflex.

It seems that the nasopalpebral reflex belongs to a special group of protective indirect reflexes in which the receptors are not exclusively in the skin, but in all tissues beneath the skin as well, situated in a wide area around the effector organ with a highly responsive central focus.

The abolition of the nasopalpebral reflex in deep sleep is probably the best indication of the importance of the cortex for its normal functioning. The resistance of the corneal reflex even to the electrical shock or deeper insulin coma points, on the contrary, to its subcortical midbrain character.

Consequent to our observations of the appearance of the Babinski sign prior to the disappearance of the nasopalpebral reflex, it seems logical to infer that in deep sleep, in which the nasopalpebral reflex disappears, the Babinski sign should be present, but unfortunately, the technical side of the investigations necessary to prove this inference is much more difficult than the examination of the nasopalpebral reflex.

SUMMARY.

The presence or absence of the nasopalpebral reflex is an excellent expedient for measuring the relative depth of a state of unconsciousness.

The abolition of the nasopalpebral reflex in insulin coma is an objective neurological sign indicating the beginning of a definite, not injurious, stage of the comatose condition, which can thus be sustained with exactness as long as it is therapeutically desired.

The nasopalpebral reflex is absent in other comatose conditions and after epileptic seizures, indicating the deeper level of unconsciousness. It is absent in deep physiological sleep.

The nasopalpebral reflex belongs to a special type of indirect exteroceptive responses.

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A NOTE ON THE AMMONIA AND GLUTAMINE CONTENT OF THE CEREBROSPINAL FLUID.

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TASHIRO (1922) showed that the isolated frog nerve liberates ammonia on stimulation, and Richter and Dawson (1948) have recently found that ammonia is liberated on stimulation by the brain. Ammonia is very toxic to the brain, on which it has an irritant action; but the brain may be protected to some extent by the enzyme system described by Krebs (1935), which can detoxicate ammonia by combination with glutamic acid to form glutamine. Sapirstein (1943) obtained evidence that this system is active *in vivo* by showing that glutamic acid increases the resistance of animals to convulsions produced by injecting ammonium chloride. The toxic action of ammonia on the brain is also of interest in connection with the view that it may be concerned in certain forms of epilepsy (Harris, 1945). This view is supported by the observations of Price, Waelsch and Putnam (1943) on the inhibitory action of glutamic acid on *petit mal* attacks.

Direct estimations of the ammonia content of the brain *in vivo* are clearly difficult to carry out, but Riebeling (1930) and Brühl (1938) reported some years ago that the cerebrospinal fluid contains an appreciable amount of free ammonia, which they believed to have diffused out of the brain. They found that the ammonia level in the C.S.F. was considerably increased in epileptics after seizures, and Brühl suggested that it might thus serve as an indicator of cerebral irritation. It might be expected that there would be an increase in the C.S.F. ammonia level after "electronarcosis" or electroshock treatment, if it reflects the liberation of ammonia in the brain; but the older work on the ammonia content of the C.S.F. can no longer be taken as reliable, and the results of Riebeling and Brühl would appear to require reinvestigation in view of the report of Harris (1945) that the C.S.F. contains an appreciable amount of glutamine, which interferes with the ammonia estimation unless special precautions are taken. Glutamine is a relatively unstable compound, and it readily liberates ammonia on treatment with alkalis under the conditions commonly used for the ammonia estimation.

The object of the present investigation was to determine the ammonia content of the C.S.F. by a reliable method which takes the presence of glutamine into account, and to test if there was a rise in the ammonia or glutamine content of the C.S.F. after "electronarcosis" or electroshock treatment.

At the same time a few observations were made on the ammonia content of the C.S.F. taken from epileptics after seizures.

METHODS.

The experiments on "electronarcosis" and electroshock treatment were performed on 9 male schizophrenics, of whom 5 were early cases of less than 3 months' duration and 4 were chronic cases of over 5 years' duration: they were all quiet and co-operative at the time. The epileptics comprised 4 male and 1 female patients, all of whom were subject to *grand mal* attacks. In the preliminary experiments the lumbar punctures were performed by the medical officer in charge of the patients, using an ordinary coarse-gauge needle: in the later experiments they were carried out by one of us (D. R.), using a fine-gauge needle (Pitkins Size 1000), which was inserted with sufficient accuracy to obtain a specimen with a single insertion. The first ml. of C.S.F. was always discarded, and then 5 to 10 ml. were collected in a stoppered test-tube, which had been specially cleaned by the method described by Conway (1939). Ammonia was estimated by the Conway (1939) micro-diffusion method, using 0.0004 N HCl and 0.0015 N baryta with Tashiro's indicator. The baryta was delivered from a micrometer syringe, which was capable of delivering quantities down to 0.0001 ml., or far less than the error inherent in detecting the indicator change at these concentrations. The baryta was kept in a rubber-capped bottle to avoid contamination by the CO_2 in the air and the solution was restandardized daily. A correction was made for the ammonia liberated by the slow hydrolysis of the glutamine in the C.S.F. in the presence of the potassium carbonate used in the Conway method. Preliminary tests with pure crystalline glutamine showed that the rate of liberation of ammonia by hydrolysis was 0.001 mg. NH_3 per mg. glutamine per hour at 20° C. under the experimental conditions. The ammonia estimations were generally carried out immediately after withdrawal of the C.S.F., but it was observed that the C.S.F. could be kept in the refrigerator at 0° C. for periods up to 12 hours without any significant change in the ammonia content. An estimation on a standard ammonium chloride solution was included in every series of estimations. Glutamine was estimated by the method of Harris (1943), in which the glutamine was hydrolysed by incubation for 75 min. with 10 per cent. trichloroacetic acid at 70° C.

Electrical stimulation of the brain was carried out with a Shotter Rich Electronarcosis Apparatus, using an initial current of 160 ma. applied through electrodes 1.5 by 2 in. placed 2½ in. in front of the mastoid process and 1½ in. above the upper border of the zygomatic arch. After 30 seconds the current was dropped to 70 ma., and when the patient was breathing satisfactorily increased by 5 ma. every 15 seconds, until respiratory stridor was observed. The electrical stimulation was continued for 7 minutes, as described by Tietz, Thompson, van Harreveld and Wiersma (1946). An injection of 1/100 gr. atropine sulphate was given before the treatment to reduce salivation. The electroshock treatment was given with a standard apparatus, using a voltage just sufficient to produce generalized convulsions after application for 1/3 second.

RESULTS.

The preliminary experiments confirmed the report of Harris (1945) that the C.S.F. contains glutamine. In a series of 8 schizophrenics the individual values ranged from 6.9 to 8.6 mgm. glutamine per 100 ml., with a mean of 8.0: these figures are all within the normal range. The preliminary experiments also suggested that the C.S.F. might contain a significant amount of free ammonia: one specimen collected from an epileptic 45 minutes after a *grand mal* seizure gave the high value of 0.27 mgm. ammonia per 100 ml., and there appeared to be a rise in the ammonia content of the C.S.F. after "electronarcosis" treatment (7 minutes' electrical stimulation).

Patient No.	Normal resting state.		After electrical stimulation.		
	Ammonia (mgm. %).	Glutamine (mgm. %).	Time after start of stimulation (minutes).	Ammonia (mgm. %).	Glutamine (mgm. %).
1	0.02	7.8	75	0.07	7.7
2	0.02	8.6	60	0.20	7.1
3	0.02	7.7	25	0.28	6.0

It was noted that C.S.F. specimens contaminated by even a trace of blood gave high ammonia figures: in 4 such specimens the observed values were 0.07, 0.10, 0.05 and 0.14 mgm. per cent. ammonia. It was also found that the ammonia content of the C.S.F. could be raised experimentally by incubating with 2-3 per cent. of blood at 37° C. for 40 minutes: in 3 such experiments the ammonia level was raised from 0.01 mgm. per cent. to 0.05, 0.03 and 0.10 mgm. per cent. ammonia. Careful analysis of the above figures obtained after electrical stimulation showed further that the apparent rise in the ammonia content of the C.S.F. was accompanied by a fall in the glutamine content. This suggested that the ammonia in the C.S.F. had not come from the brain, but that it had come from the breakdown of glutamine in the C.S.F. through the action of glutaminase liberated into the C.S.F. through local tissue damage

TABLE I.—*The Effect of Electrical Stimulation on the Ammonia and Glutamine Content of the C.S.F.*

Patient No.	Normal resting state.		After electrical stimulation.		
	Ammonia (mgm. %).	Glutamine (mgm. %).	Time after start of stimulation (minutes).	Ammonia (mgm. %).	Glutamine (mgm. %).
(a) Electronarcosis:					
8	0.00	8.1	45	0.03	8.0
9	0.00	6.9	30	0.00	6.2
10	0.03	8.6	75	0.04	8.8
11	0.07	8.1	40	0.00	8.2
(b) Electroshock:					
12	0.00	7.9	10	0.00	7.6
13	0.00	—	10	0.00	7.5

by the lumbar puncture needle: this could happen either at the time when the C.S.F. was being taken, or as a result of the previous lumbar puncture in the normal resting state.

These conclusions received confirmation in a later series of experiments, in which special precautions were taken to minimize tissue damage and the leakage of serum into the C.S.F. by using a specially fine lumbar puncture needle and making only a single insertion of the needle. Under these conditions considerably lower C.S.F. ammonia figures were obtained, and no significant rise was observed after "electronarcosis" or after convulsions induced by electroshock treatment.

No significant amount of free ammonia was found in specimens of C.S.F. taken with the same precautions from 4 epileptics at various times after *grand mal* seizures. In one case the specimen was taken after *status epilepticus* lasting approximately 12 hours. The results may be summarized as follows:

Patient No.	Time after attack (minutes).	C.S.F. ammonia (mgm. %).	Remarks.
14	35	0.01	<i>Grand mal.</i>
15	40	0.03	" "
16	120	0.00	<i>Status epilepticus</i>
17	40	0.00	<i>Grand mal.</i>

DISCUSSION.

The observation that electrical shock treatment affects the nitrogen metabolism of the brain (Richter and Dawson, 1948) would appear to be relevant in connection with the problem of how the effects of electrical shock treatment are produced. It is possible that the liberation of ammonia in the brain might account in part for the increased cerebral irritability after electrical stimulation and in other conditions. This suggested an investigation of the effect of electrical stimulation on the ammonia content of the cerebrospinal fluid.

The present work confirms the observation of Harris (1945) that the C.S.F. contains a significant amount of glutamine, which interferes with the ammonia estimation if it is not taken into account. Glutamine liberates ammonia on treatment with dilute alkalis under the conditions commonly used for the ammonia estimation: the C.S.F. may also contain a variable amount of free ammonia due to local tissue damage by the lumbar puncture needle, unless special precautions are taken to avoid this. In view of these serious sources of error, the observations of Riebeling (1930), Brühl (1938) and others can no longer be taken as valid. When precautions were taken to avoid these sources of error, no significant amount of ammonia was found in 16 successive specimens of C.S.F.; of these, 4 were collected after "electronarcosis" treatment, 2 after electroshock treatment and 4 after *grand mal* epileptic seizures. By the methods used it could be shown that the ammonia content of the C.S.F. was generally less than 0.01 mgm. per cent., or less than one part in ten millions. It was concluded that the diffusion of ammonia, in significant amounts, out of the brain into the C.S.F., if it occurs at all, is not a general phenomenon.

There is no evidence that cerebral stimulation causes a liberation of ammonia into the C.S.F., and the C.S.F. ammonia level is not a reliable indicator of the degree of cerebral irritation.

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ADRENAL CORTICAL STEROIDS AND THE METABOLISM OF GLUTAMIC ACID IN GLUCONEOGENESIS.

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THE adrenal cortex is the pivot of the body's reaction to stress. To this gland converge most of the varied effects of shock and stress, and from this gland diverge the steroids which, in ways but partly known, enable the body to withstand the stress. No apology is therefore needed for a study which contributes to an elucidation of the actions of these steroids.

It has been known since the work of Long, Katzin and Fry (1940) that adrenal cortical steroids are necessary for normal gluconeogenesis, for the fasting adrenalectomized rat is unable to convert its protein stores to glycogen and the liver becomes depleted. The process, and the liver-glycogen, can, however, be fully restored by giving some of the adrenal cortical steroids, especially those which are hydroxylated or ketonic at C-11 and hydroxylated at C-17 (Olson, Thayer and Kopp, 1944). But the chain of metabolic processes from protein to glycogen is long, and in this chain the site of action of the steroids is unknown.

In order to localize their actions more narrowly, we have supplied the adrenalectomized rat with substances which occur at some stages of gluconeogenesis in order to see whether the animal can complete the process. Glutamic acid was tested as it is of special interest. It holds a key position in the processes of deamination; for it links those amino-acids which can be converted to glutamic acid (of which histidine, arginine, proline, and lysine are already known) to glutamine and α -ketoglutaric acid, substances known to be active in the Krebs' cycle.

In addition, both glutamic acid and the adrenal cortical steroids have been reported to possess anticonvulsant properties (McQuarrie, Anderson and Ziegler, 1942; Selye, 1942; Spregel and Wycis, 1945; Kerman, 1947; but denied by Goodman, Swinyard and Toman, 1946). These observations are at present of uncertain significance, but they add to the many lines of evidence which suggest that the adrenal cortical steroids and glutamic acid play an important part in brain metabolism.

METHOD.

Adult white rats of Wistar strain, of weights between 150 and 200 gm., male to avoid possible disturbances by oestrus, were used throughout.

Their diet was maintained carefully constant in composition to avoid disturbance by the "protein effect": that glycogen stores from a diet high in

protein decrease in fasting at a rate different from those formed from a low-protein diet (Todd, Barnes and Cunningham, 1947). The diet was composed of: 50 per cent. (w/w) rat cube meal (N.E. Agricultural Co-operative Society), 10 per cent. meat meal, 10 per cent. wheat germ, 10 per cent. maize meal, 10 per cent. soya flour, 5 per cent. crushed oats, and 5 per cent. full cream dried milk. Each rat received each day 0.5 gm. of a mixture of cod-liver oil and Yeastex in equal parts.

The rats were adrenalectomized by the lumbar route under ether anaesthesia. After operation, the animals were kept in a separate room thermostatically maintained at 70° F., and the drinking water changed to 0.9 per cent. (w/v) sodium chloride with 5 per cent. (w/v) glucose; but from the second day onwards the glucose was omitted. Food of the composition described was given freely until the evening of the fourth day, when all food was removed in accordance with the demonstration by Eggleston, Johnston and Dobriner (1946) that at least six hours' starvation is necessary if the liver is to be almost entirely depleted of glycogen. Throughout the fifth day, 0.9 per cent. (w/v) sodium chloride was freely available, but there was no food, and particular care was taken to ensure that none was obtained from any irregular source. During the fifth day, the substances were administered by a course of seven injections, given intraperitoneally in a volume of 0.6 or 0.8 ml., at 45-minute intervals.

At 45 minutes after the final injection, the animal was anaesthetized by an intraperitoneal injection of 5 per cent. sodium amytal, and the body was weighed. As preliminary trials had shown that the glycogen content of the liver varied considerably from lobe to lobe, the whole liver was removed; it was snipped piecemeal into 30 ml. of 30 per cent. (w/v) KOH in a boiling water bath, and, when digestion was complete, the glycogen was estimated by the method of Good, Kramer and Somogyi (1933). The glycogen contents have been expressed throughout the paper as mg. of glycogen per 100 gm. of whole body weight.

The substances tested were: dl-alanine, l(+)-arginine, l(-)-cystine, l(+)-glutamic acid, glycine, l(+)-histidine, l(+)-lysine, l(-)-proline, dl-serine, l(-)-tyrosine, dl-valine, and glucose. The amino-acids were first brought to pH 7.4 by the addition of sodium hydroxide, and 0.2 gm. was injected either in solution or in suspension. The animals tolerated the injections well, and signs of shock were rare and slight.

RESULTS.

Absorption of Glucose.

In order to test whether the substances given intraperitoneally were being adequately absorbed, the presence or absence of any unabsorbed fluid or material was always noted when the abdomen was opened for removal of the liver. Usually the peritoneal space was empty, but when any fluid was present it was carefully collected, its glucose content was estimated chemically, and the amount unabsorbed was thus determined. Usually the absorption of glucose was complete, but when incomplete, the quantity absorbed was never less than 70 per cent. of the injected quantity.

Absorption of Amino-acids.

Some of the amino-acids failed to dissolve completely in the fluid available, and were injected in suspension. Incomplete absorption occurred with some of the amino-acids, especially with the less soluble ones like cystine and tyrosine. Precise details cannot be given since the animals varied among themselves, but most of the amino-acids were absorbed completely. The question will be referred to again below.

Formation of Glycogen from Glucose.

When glucose was given, at doses varying from 0.105 gm. to 1.68 gm., to the adrenalectomized rat, it was found (Fig. 1) that glycogen deposition occurred

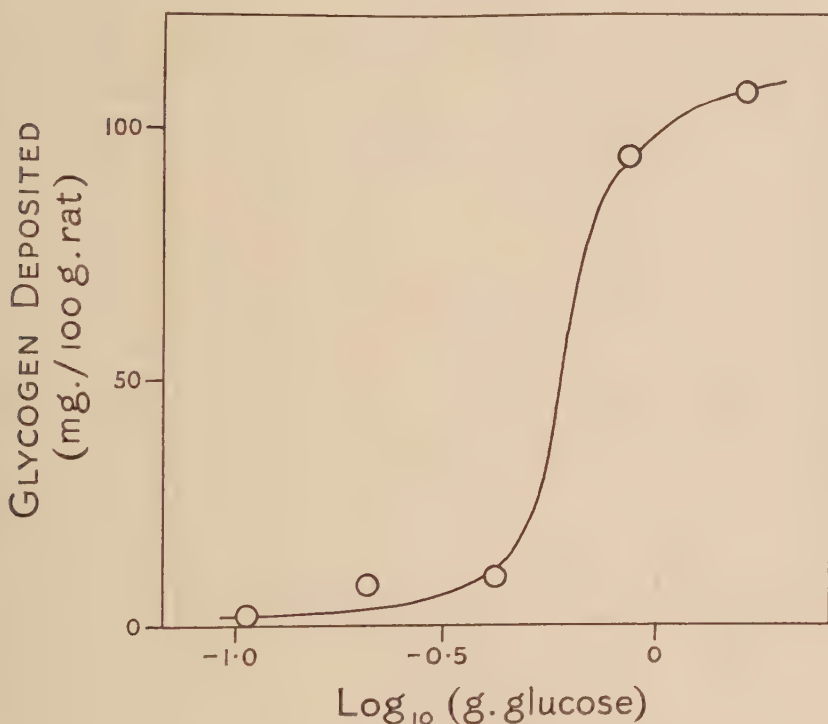


FIG. 1.—Glycogen deposited in the liver of the adrenalectomized rat after the intra-peritoneal injection of glucose at doses ranging from 0.105 to 1.68 gm. Each circle is the mean of 5 animals.

freely provided that the dose exceeded about 0.5 gm. (-0.3 on the logarithmic scale). This occurrence of a threshold confirms the experience of Venning, Kazmin and Bell (1946) in the mouse. (Their work has been repeated here in order to provide a proper control for the experiments described below.) A plausible explanation is that the animal, fasting during the administration

of the test-substance, expends about 0.5 gm. of glucose in its metabolism so that only if an excess over 0.5 gm. is provided can glycogen be deposited. Be that as it may, Fig. 1 shows that, in the adrenalectomized rat, glucose can be converted easily to glycogen.

Formation of Glycogen from Glutamic Acid.

Because this basal quantity (0.5 gm.) of glucose is needed before glycogen deposition can begin, it was considered advisable to give all the animals glucose sufficient to cause a small but definite deposit of glycogen; then the action of other substances was tested by seeing whether they increased the amount of glycogen deposited. Accordingly, all the experiments were duplicated, half of the rats receiving 0.42 gm. and half 0.63 gm. of glucose.

To test the ability of the adrenalectomized rat to convert glutamic acid to glycogen, eight sets of four rats were used, each set of four receiving one of the eight combinations of (1) glucose at doses of 0.42 gm. or 0.63 g.m, (2) adrenal cortical extract (Eschatin) at doses of 0 or 0.1 ml. (a dose just sufficient to give a detectable effect), and (3) glutamic acid at doses of 0 or 0.2 gm.

As the rats responded to all four combinations of glucose and Eschatin similarly, the results have been combined to give Table I.

TABLE I.—*Glycogen Deposited with and without Glutamic Acid.*

Treatment.	No. of rats.	Glycogen deposited (mg./100 gm. rat).	S.D.
Basic	16	42.3	±3.2
Basic + glutamic acid	16	36.3	±3.9
Difference .		6.0	±5.0

(The standard deviations (S.D.) are those of the quantities on their left.)

It will be seen that the addition of glutamic acid has resulted in no increase in the deposit of glycogen; in fact, the deposition is reduced, though not significantly.

Partly to repeat the experiment, and partly to encourage glycogen deposition, the experiment was repeated, but using 0.2 ml. of Eschatin throughout. This dose had been found by previous trial to be able to cause only a small deposition of glycogen. Glutamic acid was again given with glucose at doses of 0.42 and 0.63 gm. The results are given in Table II.

TABLE II.—*Glycogen Deposited with and without Glutamic Acid.*

Treatment	No. of rats.	Glycogen deposited (mg./100 gm. rat).	S.D.
Basic + Eschatin .	16	63.4	±5.5
Basic + Eschatin + glutamic acid	16	55.3	±3.2
Difference .		8.1	±6.4

Again the administration of glutamic acid has caused no increase in the amount of glycogen deposited; in fact the deposit is smaller, though not significantly so. Evidently a quantity of Eschatin just sufficient to cause some deposition of glycogen from glucose is insufficient to convert the glutamic acid to glycogen.

The two experiments agree in showing that, in the adrenalectomized rat, glutamic acid is not readily converted to glycogen.

Formation of Glycogen from Other Amino-acids.

Ten other amino-acids (listed above) were given similarly. Half the animals received 0.42 gm. of glucose and half received 0.63 gm. These batches were again split, half receiving 0.1 ml. of Eschatin and half receiving none. Control groups were given treatments similar to these except that no amino-acid was given.

The results (Table III) showed that in general, the supplying of amino-acids did not result in glycogen deposition. On the contrary, the tendency was for the deposition to be inhibited.

TABLE III.—*Glycogen Deposited with and without Amino-acids.*

Treatment.	No. of rats.	Glycogen deposited (mg./100 gm. rat).	S.D.
Basic	40	41.8	±2.3
Basic + amino-acid	40	24.2	±1.8
Difference		17.6	±2.9

The difference between the two means is significant, for it exceeds six times its standard error ($P < 0.001$).

In the adrenalectomized rat, therefore, amino-acids are not readily converted to glycogen.

Effects of Individual Amino-acids.

In order to investigate adequately the differences between the individual amino-acids, a "factorial" design of experiment was used. Each amino-acid was tested as before on four basic treatments; two levels of glucose (0.42 or 0.63 gm.), both with and without Eschatin 0.1 ml. The ten amino-acids and two batches of glutamic acid were used, and each was tested on 8 rats.

When the results were examined, the analysis of variance showed that the second-order interaction (Table IV) was almost significant when compared with the residual variance; for this reason, and especially as it is the variance between amino-acids in which we are interested, the variance of the second-order interaction has been used as the estimate of error.

The result marked (1) in the right-hand column of Table IV shows that the amino-acids are significantly different from one another in their effects on glycogen deposition; evidently the amino-acids have specific as well as general effects.

Table V shows, for each amino-acid, the mean over the four basic treatments of the differences between the amounts of glycogen deposited when the amino-

TABLE IV.—*Analysis of Variance.*

Variance.	D.F.	Sum sq.	Mean sq.	Var. ratio.	P.	Sigce.
Amino-acids (A)	II	42729	3888	7.76	0.001	** (1)
Cortical extr. (C)	I	29601	29601	59.0	<0.001	** (2)
Glucose level (G)	I	884	884	1.76	>0.05	0
Interaction: AC	II	12535	1140	2.27	>0.05	0 (3)
„ AG	II	9506	864	1.72	>0.05	0 (4)
„ CG	I	2670	2670	5.32	0.04	*
„ ACG	II	5514	501	—	—	—

Total . . . 47 .103440 . — . — . — . —

0 = not significant.

* = significant at 5% level.

** = significant at 1% level.

TABLE V.—*Inhibition of Glycogen Deposition Caused by Amino-acids.*

Amino-acid.	No. of rats.	Change in glycogen (mg./100 gm. rat).
Glycine . . .	8	-32.0
l(-)-Tyrosine . . .	8	-31.3
l(-)-Cystine . . .	8	-30.6
l(+)-Lysine . . .	8	-23.3
l(+)-Histidine . . .	8	-22.4
l(+)-Arginine . . .	8	-21.9
dl-Alanine . . .	8	-18.8
dl-Serine . . .	8	-12.2
l(-)-Proline . . .	8	-7.5
l(+)-Glutamic acid . . .	8	-6.0
dl-Valine . . .	8	+18.7
(Controls) . . .	(48)	(0)

acid was given and the amounts when it was not given. (A negative sign implies that the glycogen deposit was less when the amino-acid was given.) Thus, the administration of 0.2 gm. of glutamic acid tended, other things being equal, to lower the deposit of glycogen by 6.0 mg./100 gm. rat. (It may be noted that this result with glutamic acid confirms those of Tables I and II.) The tendency of the amino-acids to inhibit glycogen deposition is clearly shown, and the deviation of the mean from zero is significant ($t = 3.80$, $n = 10$, and $P < 0.01$.)

DISCUSSION.

As shown by Fig. 1, the adrenalectomized rat can convert glucose to glycogen without difficulty if more than a minimal quantity is supplied. Similarly it has been found that the adrenalectomized mouse can deposit glycogen from glucose which has been given by injection (Venning *et al.*, 1946), and that the adrenalectomized rat can deposit glycogen from glucose given by stomach tube (Deuel,

Hallman, Murray and Samuels, 1937). In the processes of gluconeogenesis, therefore, the adrenal cortical steroids seem to act only slightly, if at all, in the conditions of our experiment, in the stages in which glucose is converted to glycogen.

Amino-acids, however, seem unable to proceed to glycogen in the absence of these steroids. But before discussing this inability, a possibility must be excluded. Could this failure to deposit glycogen be due to a simple failure in the absorption of the amino-acids? Its likelihood seems small: the completeness of absorption was in most cases shown to be complete by inspection of the peritoneal cavity, and was, for glucose, confirmed by chemical assay; and there is the fact that the amino-acids have demonstrated a definite effect (Table V), which, though one of inhibition, shows that a sufficient absorption has occurred. It seems, therefore, that the chief difficulty in gluconeogenesis without steroids must lie in those processes which convert amino-acids to glucose and its related substances.

That the steroids promote deamination has been suggested by the work of Russell and Wilhelmi (1941a), who showed, in kidney slices of the rat, that dl-alanine and l(-)-glutamic acid were deaminated at a rate which was less in slices from the adrenalectomized than in slices from the normal rat. They found, also, that the decreased rate of deamination could be restored to the normal level by the addition of adrenal cortical extract or of desoxycorticosterone. (In the last respect their work does not parallel ours, for it has repeatedly been found (e.g. Reinecke and Kendall, 1943; Olson *et al.*, 1944) that desoxycorticosterone does not promote gluconeogenesis in the adrenalectomized rat.) They also showed (1941b) that previous adrenalectomy reduced not only the rate of deamination but also the rate of formation of carbohydrate.

The conversion of alanine to glucose in the adrenalectomized rat has also been measured by the use of the phloridzinized animal (Lewis, Kuhlmann, Delbue, Koepf and Thorn, 1949). They found that this conversion was impaired on adrenalectomy, that impairment was corrected by adrenal cortical extract (Wilson Laboratories) and by 17-hydroxy-11-dehydro-corticosterone, but not by desoxycorticosterone. It may be significant that the potencies of these steroids in the conversion of alanine to glucose are similar to their potencies in gluconeogenesis, for in both processes desoxycorticosterone is inactive (Reinicke *et al.*, 1943) while adrenal cortical extracts and 17-hydroxy-11-dehydrocorticosterone are active (Olson *et al.*, 1944).

Related to this effect is the fact that adrenalectomy reduces, in rat liver, the activity of arginase (Fraenkel-Conrat, Simpson and Evans, 1943). The activity can be restored by some steroids, for corticosterone, 11-dehydro-corticosterone, and 17-hydroxy-11-dehydro-corticosterone are active while desoxycorticosterone is without effect. Again their relative potencies in the activation of arginase match their relative potencies in gluconeogenesis.

The Inhibition of Glycogen Deposition by Amino-acids.

The data of Tables III, IV and V show that the administration of amino-acids inhibits, to some degree, the deposition of glycogen in the adrenalectomized

rat. A review of the technical details has suggested no simple explanation, and we may turn to others' work for comparison.

A possible confirmation of the fact has been given by Chiu and Needham (1948) who found that rabbit liver slices in 0.4 per cent. dl-alanine, in conditions favourable for glycogen deposition, changed in glycogen content: with Eschatin, from 1.09 to 1.18 mg./gm., without Eschatin from 1.09 to 0.79 mg./gm. In their conditions, with no substrate and with no Eschatin, the glycogen is stated to have increased slightly. So the fall in glycogen from 1.09 to 0.79 mg./gm. when alanine was present may be analogous to our inhibition. But the interpretation is complicated by uncertainty as to what quantity of steroid has been brought to the experiment by the tissue, and also how long the quantity has continued effective. The work of Vogt (1943) suggests that the quantity would be soon consumed.

The normal animal, supplied with amino-acids, can deposit glycogen without difficulty. In fact, the administration of glycine having C^{13} in the carboxyl group has shown not only that the glycine is converted to liver glycogen, but that the ingested glycine promotes the formation of glycogen from other body constituents (Olsen, Hemingway and Nier, 1943). The normal and the adrenalectomized animals evidently react very differently to the administration of amino-acids.

The comparative powers of the different amino-acids to inhibit glycogen deposition, shown in Table V, give as yet no clue to the underlying reason for the inhibition. The amino-acids have also been arranged in order of their specific dynamic activities (Lusk, 1912; Rapport and Beard, 1937), but no clear correspondence emerges; nor does it when they are arranged in order of their powers to form glucose in the phloridzinized dog (Ringer and Lusk, 1910; Dakin, 1913*a, b, c*).

CONCLUSION.

The results show that failure of gluconeogenesis in the adrenalectomized rat is due primarily to an inability to convert glutamic acid to glucose and its related substances. Secondary to this is the failure of the other amino-acids to be converted to glycogen; for an inability to convert glutamic acid will obstruct all the amino-acids whose metabolic paths in gluconeogenesis lie through glutamic acid, glutamine, and α -ketoglutaric acid.

Reactions to shock, insofar as they involve the adrenal cortical steroids, may therefore affect in this way the metabolism of glutamic acid.

SUMMARY.

(1) The adrenalectomized rat is unable to convert glutamic acid to glycogen, but the conversion of glucose to glycogen is unimpaired.

(2) Under these conditions, other amino-acids are also unable to proceed in gluconeogenesis.

(3) The administration of glutamic acid and of other amino-acids to the adrenalectomized rat causes a partial inhibition of gluconeogenesis.

(4) A mechanism is suggested through which the reaction to stress may affect the metabolism of glutamic acid.

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PHYSIOLOGICAL CONCOMITANTS OF ELECTRONARCOSIS.*

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ELECTRONARCOSIS is the term applied to a sleep-like condition produced by the passage of an electric current through the central nervous system.

The condition only superficially resembles sleep; the term electronarcosis is a misnomer, and electrocoma therapy might be a more apt term for this form of treatment.

The condition has been known for many years. Leduc (1902) produced a narcosis-like state in animals by means of a unidirectional pulse count. He had the procedure applied to himself, and described the experience as a dream-like state in which painful sensations were diminished.

Frostig *et al.* (1944) published a relatively safe technique of producing electronarcosis in human beings. Tietz, Thompson *et al.* (1946) first used electronarcosis in the treatment of schizophrenia. Spencer Paterson (1947) introduced the treatment to Great Britain, and reported that the first impressions of the results of treating schizophrenia by this method were favourable.

There are as yet very few reports available on the efficacy of the treatment; furthermore, little is as yet known of the precise mode of action of electrotherapeutic procedures, or the exact physiological or biochemical changes, if any, which play a part in producing therapeutic results. It is, therefore, of intrinsic as well as of practical interest to determine the physiological effects of electrotherapeutic procedures, and this paper describes some observations on physiological changes noted in a group of 30 schizophrenics undergoing electronarcosis therapy.

TECHNIQUE.

The technique adopted was that described by Spencer Paterson (1947) using the Shotter-Rich apparatus.

Premedication.

Seconal (grains 3-4½) and atropine (one to two seventy-fifths of a grain) is given about 40 minutes before starting treatment. The seconal is given to allay apprehension and reduce restlessness, and the atropine to reduce parasympathetic effects such as excessive salivation, bronchial secretion and cardiac inhibition.

In the observations to be described, control experiments were carried out to determine whether any of the changes were due to the pharmacological effects of atropine or seconal.

* Part of paper read at the Quarterly Meeting of the South-Western Division of the Royal Medico-Psychological Association at Cardiff City Mental Hospital, April, 1948.

An alternating current is applied through two head electrodes in two stages.

First stage consists in the passage of a current of 160–200 milliamps for 30 seconds. In the group of patients on whom the observations to be described were made the current was applied in full strength immediately; the so-called "glissando" technique of gradually increasing the current strength to the required level during the course of a few seconds was not used in this series.

Second stage begins at the end of 30 seconds with the reduction in current strength to 65 milliamps. Respiration, which was arrested during the first stage, restarts in about 15 seconds. When respiratory action becomes well established the current is increased by 15 milliamps every 15 seconds until the required degree of narcosis is produced, as is conveniently indicated by a moderate degree of inspiratory stridor. The current is terminated at the end of 7 minutes.

Motor System.

Immediately the current is switched on there is a tonic contraction of the extremities. After 10–15 seconds there is an extension of the legs with opisthotonos. The arms are flexed, sometimes adducted and sometimes abducted, with the hands clenched in the tetanic position or with thumb interposed between second and third fingers.

When the current is reduced at the commencement of the second stage clonic movements occur, qualitatively similar to those occurring in electroconvulsion, but of smaller intensity. The higher the initial current the more strong the clonic movements tend to be.

Respiratory movements follow the clonic contractions usually 40–45 seconds after the commencement of the treatment. Extensor tone in legs and flexor tone in the arms persists until the current is switched off, when muscle tone returns almost immediately to normal.

Cardiovascular System.

(a) *Heart rate.*—Immediately following the application of the initial current there is a short period of cardiac arrest followed by a slow irregular heart rate. The inhibitory effect on the heart is transient, and after a few seconds the rate returns to normal, to be followed usually by a tachycardia in the second stage, sometimes reaching 160–170 beats a minute.

The cardiac inhibitory effects of electronarcosis were less noticeable after premedication with atropine gr. $\frac{2}{5}$ ths, suggesting that they were attributable to vagal overactivity. Animal experiments by Frostig (1944) in fact confirm this as the inhibitory changes were abolished by vagal section.

Electrocardiograms taken before and after electronarcosis showed no significant changes.

(b) *Blood pressure.*—It is not possible to measure blood pressure during the first stage owing to rigidity, or in the second stage until clonic movements pass off.

It can reasonably be assumed that a fall in blood pressure occurs during the stage of cardiac arrest and slow heart rate, as has been found in animal

experiments (Frostig, 1944). With the return of heart rate to normal the blood pressure rises to the pre-treatment level.

Blood-pressure readings in the second stage show an increase up to 180–220 mm. Hg systolic pressure and up to 100–150 mm. Hg diastolic pressure.

As a rule the pressure tends to remain high throughout the electronarcosis, but immediately falls to about 140–150 systolic mm. Hg when the current is switched off, returning to the pre-treatment level in 2–3 minutes after the current is switched off.

This marked rise of blood pressure is of practical importance, as it indicates the need of caution in applying electronarcosis to hypertensive patients.

The sudden drop in blood pressure occurring when the current is switched off suggested that the increased muscular tension might contribute to the high blood-pressure readings.

In order to determine whether the rise in blood pressure was attributable to increased muscular tension, tubocurarine was given to patients immediately prior to electronarcosis, to produce muscular relaxation. Blood-pressure readings in curarized patients showed a similar marked increase in blood pressure, and a similar sudden fall with cessation of the current in spite of the flaccidity of the muscles.

The changes in blood pressure, therefore, cannot be attributed to the changes in muscular tension and are assumed to be due to sympathetic stimulation analogous to the vagal overactivity noted in the first stage.

Autonomic Responses.

In addition to the autonomic effects noted in connection with the cardiovascular system, there are many clinical changes indicative of autonomic stimulation both in the sympathetic and parasympathetic divisions, such as—

1. Flushing of face and neck.
2. Increased bronchial secretion.
3. Increased lachrymation.
4. Increased sweating.
5. Pilomotor stimulation.
6. Increased gastro-intestinal activity.
7. Enuresis.

The type of autonomic response varies with the patient, and is not always constant with each treatment.

Blood Sugar.

Blood-sugar readings were taken before electronarcosis and at regular intervals for 2½ hours afterwards. Control experiments were carried out under precisely similar conditions with the omission of electronarcosis. The results are shown in Fig. 1. There is invariably a rise in blood sugar with electronarcosis which is maintained for about 30 minutes and then gradually falls, reaching the resting level in 2–3 hours.

The degree of hyperglycaemia is not constant with each treatment, and may vary from 40–100 mgm. per 100 c.c. above the resting level. The control experiments showed no significant changes in blood-sugar level, indicating that

the changes were attributable to electronarcosis and not premedicative drugs or other causes.

The blood-sugar changes cannot be attributed to anoxaemia, as Frostig was able to show that a blood-sugar rise occurred during electronarcosis in tracheotomized dogs. It is assumed that the rise in blood sugar is another result of sympathetic stimulation occurring during electronarcosis.

Cerebrospinal Fluid.

Examination of the cerebrospinal fluid before and after electronarcosis failed to show any significant changes in ammonia content and other chemical constituents. This investigation is described in detail elsewhere (Richter, Dawson and Rees).

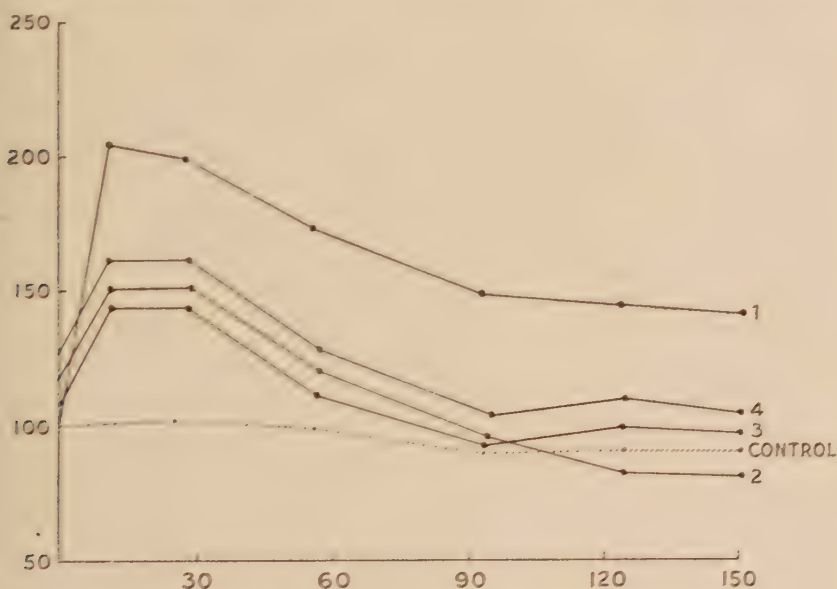


FIG. 1.—Blood-sugar curves of a patient undergoing electronarcosis.

Blood Picture.

Frostig *et al.* (1944) reported an increase in total red and white cell count accompanying electronarcosis in animals, but did not report any investigation into possible fluctuations in the various types of leucocyte.

For this study special attention was, therefore, paid to the fluctuations of the various white cells, particularly the lymphocyte, the importance of which has been established by recent work.

METHOD.

Total leucocyte and differential counts were taken before electronarcosis, immediately on termination, and at regular intervals for 2½ hours afterwards. Control experiments were carried out before starting electronarcosis treatment, in which patients received secenal and atropine premedication with blood-

counts being taken at the same time and for the same period, under identical conditions as on the treatment day. In all some 40 experiments were carried out in 10 female schizophrenics undergoing the treatment.

RESULTS.

Total white cell count.—There is considerable fluctuation in the total white cell count after electronarcosis. Usually there is marked leucocytosis immediately following electronarcosis. There is considerable individual variation, and the changes are not constant.

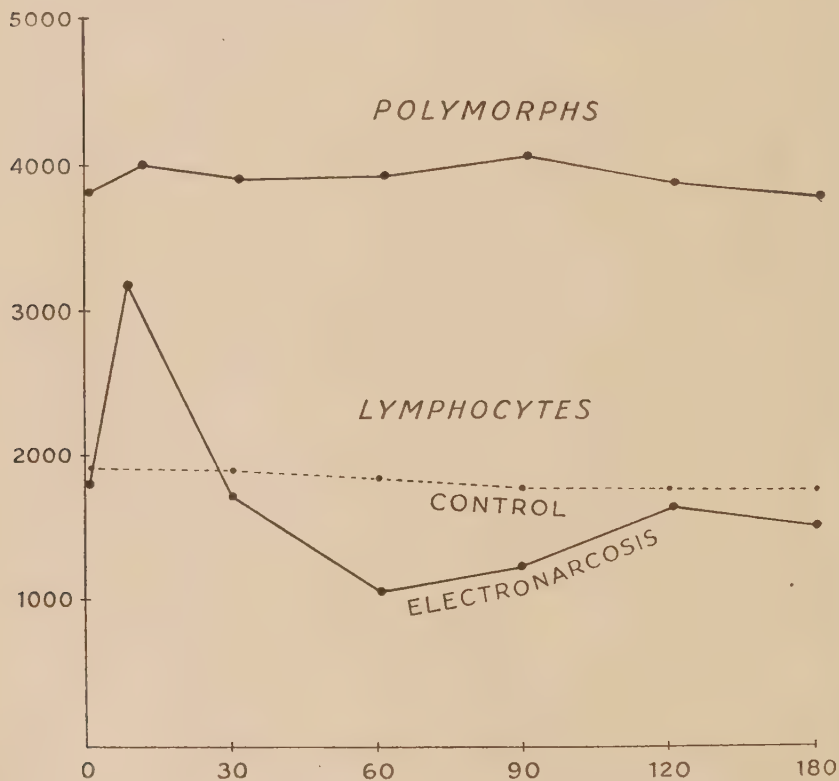


FIG. 2.—Variations in circulating lymphocytes after electronarcosis.

Polymorphonuclear leucocytes showed wide fluctuation, sometimes increasing and at other times decreasing. A composite curve for the total series shows an irregular horizontal line (Fig. 2).

Lymphocytes.—Lymphocytes in contrast to the polymorphs tended to show consistency in variation.

Fig. 2 shows a composite graph for the total series. It will be seen from the graph that there is marked lymphocytosis immediately following electronarcosis, persisting for 5–15 minutes and tending to return to the resting level by 30 minutes.

From 30–90 minutes there is a tendency for a fall in the number of circulating lymphocytes, with a gradual return to the resting level by 2 hours.

There are thus two distinct parts of the curve :

1. Lymphocytosis during the first 15 minutes after electronarcosis.
2. Lymphopenia at $1\frac{1}{2}$ –2 hours afterwards.

Lymphocytosis.—A similar lymphocytosis has been noticed after E.C.T. by Felici (1940), who found a lymphocytosis starting 5 minutes after electroconvulsion and lasting 30–45 minutes afterwards. Carse and Slater (1945) similarly reported a systematic rise in lymphocytes within the first 15 minutes of E.C.T. The authors do not discuss the possible explanation of their findings.

It seems probable that the mechanisms producing the lymphocytosis will be similar in both electronarcosis and E.C.T.

The following processes are possible explanations for the lymphocytosis :

1. Increase of total circulating blood elements due to depletion of blood reservoirs.
2. Abstraction of fluid from the blood.
3. Specific increase of circulating lymphocytes.

Frostig and co-workers (1944) found an increase in both red and white cells in dogs during electronarcosis, but they found that the difference in the dried weight of corpuscles before and after electronarcosis was too insignificant to account for these changes in terms of fluid loss. The findings could in fact be explained by depletion of blood reservoirs, particularly the spleen, as a result of sympathetic stimulation during electronarcosis.

This release of leucocytes from blood reservoirs, together with those from the unused capillaries, particularly of the lungs and liver, would probably explain the increased polymorphonuclear leucocyte level and possibly account for the lymphocytosis.

If the increase of lymphocytes and polymorphs were due to the same process, viz., depletion of blood reservoirs and from unused capillaries, one would expect to find a parallel fluctuation. This, however, is not so, as polymorphs showed wide fluctuation and variability, sometimes increasing and other times decreasing. The lymphocytes, on the other hand, showed a consistent and relatively more marked increase during the first 15 minutes. It seems probable, therefore, that the early lymphocytosis is mainly due to a specific increase in the number of circulating lymphocytes.

Drinker and Yoffey (1941) point out that an increase in the level of lymphocytes in the blood can follow—

1. Entry of lymphocytes into blood stream in increased numbers while the number leaving is unchanged (active lymphocytosis).
2. Entry of lymphocytes into blood in normal numbers, but with an exit numerically less than normal so that there is a retention of lymphocytes (relative lymphocytosis).

Process (2) *ex hypothesi* should be a gradual process, and therefore not applicable to our present problem of explaining the sudden lymphocytosis.

Drinker and Yoffey (1941) maintain that lymphocytosis of sudden onset is probably mechanically determined. In the case of electronarcosis a possible

mechanism would be an increased flow of lymph conveying lymphocytes formed in the lymph nodes to the blood stream mainly via the thoracic duct and right lymph duct.

It is well established that increased lymph flow can be caused by—

1. Muscular activity.
2. Increased venous pressure.

Both these conditions occur in electronarcosis, the more important factor probably being muscular activity according to Rous (1908).

Increased venous pressure together with anoxaemia and increased blood CO_2 , increase lymph flow by facilitating permeability of capillary wall. Increased venous pressure would be present during the first stage, but its action and that of increased blood CO_2 is unlikely to be marked not only because of their transience, slight degree and short duration in electronarcosis, but because, as Maurer (1940) has shown, increase of lymph only occurs when oxygen saturation of the blood falls to 75 per cent. of the normal and when CO_2 is increased to 10 volumes.

In view of these considerations it was clearly desirable to carry out a control experiment under identical conditions except that the patient, instead of undergoing electronarcosis, was made to do what was estimated to be at least a comparable amount of exercise (stepping on and off chair 10 times). It was found in fact that a 30 per cent. lymphocytosis was produced during the first 15 minutes, with return to resting level in 30 minutes.

In view of these findings it is considered that the lymphocytosis immediately following electronarcosis and electroconvulsive therapy is of mechanical origin, and resulting from increased lymph flow caused mainly by muscular activity.

Lymphopenic Part of Circulating Lymphocyte Curve.

Lymphopenia may be due to—

1. Diminished entry of lymphocytes into blood stream with normal rate of exit.
2. Normal rate of entry with increased exit rate.

There is no evidence to suggest that there is a diminished rate of entry of lymphocytes into the blood stream during this $\frac{1}{2}$ –2-hour period after electronarcosis due to mechanical or other causes. The fact that a fall in lymphocyte level does not occur during the corresponding interval after muscular exercises is against mechanical explanation, as is the fact that the lymphopenia was unaffected when the muscular factor was diminished by tubocurarine. The reason for the fall must therefore be looked for in factors which accelerate the exit of lymphocytes from the blood stream.

The fate of the lymphocyte has been a subject of controversy among histologists and physiologists for many years. Rich (1936) emphasized 13 years ago that the complete ignorance of the function of the lymphocyte was one of the most humiliating gaps in all medical knowledge. It has now been established that the blood lymphocytes are replaced at least twice a day. The following theories have been put forward to explain this high rate of replacement :

1. *Progenitor of other blood cells.*—Maximow (1931) thought the lymphocyte

gave rise to all other types of blood cells. Yoffey believes that the excess lymphocytes are transformed erythrocytes.

2. *Excretion into lumen of alimentary canal* was a theory advanced by Bunting and Huston (1921), and has not gained general support.

3. *Return to lymph glands*.—Sjoevall (1936) maintained that lymphocytes passed out of blood stream into tissue spaces and returned to lymph nodes by lymphatics. It is difficult to account for disposal of all the lymphocytes in this way, since the number of lymphocytes in the lymph entering a gland is one-tenth that of the lymph leaving it. Herberg (1922) maintained that lymphocytes returned to the lymph gland in the afferent capillaries, and were eventually destroyed by the macrophages of the germinal centre.

Ehrlich (1946) in a review of the subject thinks Herberg's theory the most satisfactory, and could account for the exit from the blood stream of the large numbers involved. The lymph glands would therefore be the birth-place and graveyard of the lymphocyte.

Recently White and Dougherty (1946) have shown from animal experiments that the disposal of lymphocytes is controlled by the adrenal cortex. Injections of both pituitary adrenotrophin and cortical extract produced lymphopenia in animals. They have identified the responsible corticosteroid as 11-oxy-corticosteroid. Six hours after the injection the germinal centres of the lymph nodes became oedematous and filled with degenerating lymphocytes and nuclear debris.

The interesting question now arises whether the fall in circulating lymphocytes noted in the $\frac{1}{2}$ –2-hour period after electronarcosis is due to increased adreno-cortical activity after electronarcosis. There is evidence that the diencephalic pituitary mechanism is stimulated by electrotherapy. Thus Hemphill and Reiss (1942) found an increased excretion of 17-ketosteroids after electrical convulsion. As estimation of 11-oxy-corticosteroids is very difficult, it would be of interest to carry out estimation of 17-ketosteroids as an index of adrenal cortical activity after electronarcosis therapy and, if practicable, to carry out parallel lymphocyte counts in order to clarify the question. If it were found that increased excretion of 17-ketosteroids was accompanied by a fall in the number of circulating lymphocytes, it would support the view that the fall in lymphocyte level, after electronarcosis, was due to increased activity of the adrenal cortex.

These and other findings indicate the need for further research into the physiological, biochemical and endocrinological concomitants of electrotherapeutic procedures, in order to determine whether the changes have any prognostic value, or can help in the elucidation of the precise mode of action of these empirical methods of treatment.

SUMMARY..

1. Physiological changes accompanying electronarcosis used in the treatment of a group of 30 schizophrenics are described.

2. Cardiovascular changes consist of cardiac arrest and irregular bradycardia in the first stage and a considerable rise in blood pressure in the second stage.

The cardiac inhibition is regarded as being due to vagal overactivity, and the rise in blood pressure a sympathetic effect. The rise in blood pressure is of such a degree that it might constitute a danger in hypertensive patients.

3. Rise in blood-sugar level was found to occur after electronarcosis. The degree of rise shows considerable variation with the same individual at different treatments. Available evidence suggests that the rise in blood sugar is due to the stimulation of the sympathetic-adrenal mechanism.

4. A variety of autonomic changes were noted clinically, indicating intense stimulation of sympathetic and parasympathetic parts of the autonomic nervous system during electronarcosis.

5. No significant changes were found in cerebrospinal fluid.

6. Electronarcosis was found to have marked effects in the blood picture. A polymorphonuclear leucocytosis sometimes occurred, but was not constant, and sometimes a decrease in number was found. Lymphocytes showed a consistency in fluctuation with electronarcosis. A marked lymphocytosis was found within the first 5 minutes after electronarcosis, which was maintained for about 15 minutes with a return to a normal level in 30 minutes. During the $\frac{1}{2}$ -2-hour period after electronarcosis a steady fall below the resting level was found.

7. The available evidence suggests that the early lymphocytosis is due to mechanical causes, probably muscular activity causing an increased entry of lymphocytes into the blood by increasing lymph flow to the blood stream. The causation of the lymphopenia is less clear. Recent work on the regulatory action of 11-oxycorticosteroids on lymphocyte blood level is discussed, and the possibility of the lymphopenia being attributable to increased pituitary-adrenocortical activity is considered.

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THE VALUE OF ANTHROPOMETRIC INDICES IN THE ASSESSMENT OF BODY BUILD.

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THE assessment of a patient's bodily habitus has now become an important part of clinical investigation in many medical fields.

In general medicine, body build has been found to have a significant relationship with such conditions as peptic ulcer and gall-bladder disease (Draper, 1924). In the field of psychiatry body build has been shown to have an association with the type of mental illness, to influence its progress and to determine response to treatment. It has been shown that the linear type of body build in particular, has an affinity with schizophrenia whereas the broad or lateral types of body build tend to be associated more with manic depressive psychosis (Kretschmer, 1921). A broad type of body build in schizophrenia has been found to be associated with a shorter duration of illness than in those with narrow types of habitus (Betz, 1942) and is considered to be a factor of good prognostic significance in the insulin treatment of schizophrenia (Freudenberg, 1941). Further significant relationships between body build, neurosis and personality are referred to later. These findings emphasize the importance of taking into account the physical constitution as an integral part of the total personality both in physical and psychological medicine.

There are two main methods of assessing body build :

1. Somatoscopy.
2. Somatometry.

Somatoscopy is the assessment of a person's bodily habitus by visual impression. It was the method mainly used by Kretschmer (1921) who stated "the tape measure sees nothing." Somatoscopy as a scientific procedure has inherent disadvantages. Firstly it does not lend itself to accurate quantitative assessment and secondly being a subjective procedure there is no certainty of agreement by different observers. The method is therefore unsuitable for most scientific investigations as it does not permit of repetition and validation by other workers.

Somatometry includes anthropometric measurements taken directly on the body or on standardized photographs.

From such measurements various indices of body build have been devised. A comprehensive list of such indices is given by Tucker and Lessa (1940). It would seem that the empirical considerations have determined the construction of many of these indices, some of which are of doubtful validity.

Empiricism has hitherto been unavoidable, as criteria for determining inductively which measurements are most discriminative in delineating physical

types have been lacking. Many of the indices have been based on typological theories, e.g. Viola's index and modification of it by Wertheimer and Hesketh (1926) are based on the hypothesis of Viola (1933) that the relative growth of limbs and volume of trunk are interdependent. The longer the limbs the smaller the trunk volume and giving a microsplanchnic type, and vice versa, the shorter the limbs the larger the trunk giving the macrosplanchnic type. This hypothesis cannot be regarded as being adequately validated.

If the hypothesis were correct one would expect a high negative correlation between height (or leg length) and trunk volume, i.e. the numerator and denominator of the index. Symphysis height and an index of trunk volume (Sagittal chest diameter $\times$ chest diameter transverse $\times$ trunk length) was calculated on 100 soldiers and was found to be $-0.147, -0.097$. This negative correlation is small and not statistically significant. This finding therefore tends to throw doubt on the validity of the primary assumption underlying Viola's index.

A number of indices have been based on the Kretschmerian theory of types using the subjective criteria thought to be useful in differentiating types.

Some investigations have used a circular method of reasoning. Firstly, contrasting types of physique (e.g. leptosomatic and pyknic) are segregated by visual inspection into groups and measured. The measurements are then compared and those showing the greatest differences used in forming indices. The disadvantage of this method is that it is merely providing an objective method of discriminating individuals subjectively segregated into contrasting groups of bodily architecture and that it cannot prove either the existence or nature of discrete types in the general population. This method has been used to the best advantage by Erik Stromgren (1937), who by the method of Least Squares was able to determine which measurements in combination most efficiently discriminated the types of physique segregated by impression. From this investigation resulted the well known and useful anthropometric index of Stromgren, which is a function of stature, transverse chest diameter, sagittal chest diameter (vide appendix).

The ideal method of approaching the problem, avoiding the above mentioned disadvantages, would seem to involve using the following essential steps:

1. The analysis of the variations in body build in the normal population by objective inductive methods in order to determine whether there is any evidence to support the type theory of body build.
2. The determination of the factors accounting for the variations in body build.
3. The determination of the measurements that correlate most highly with such factors.
4. The combination of these measurements in a convenient and practicable index to measure efficiently bodily habitus.

The technique of Factor Analysis, which had been used with success in the study of intelligence and personality, afforded an inductive approach to the study of the variations in body build and was first used for this purpose by Burt (1937). Burt's pupils, Cohen (1938) and Hammond (1942) carried out similar factorial studies on Jewish and Welsh groups respectively.

Rees and Eysenck (1945) carried out a factorial analysis of the intercorrelations of 26 physical measurements on a group of 200 soldiers successively admitted to Mill Hill Emergency Hospital, London.

Each measurement was correlated with the others, giving a total of 200 intercorrelations. The table of intercorrelations was analysed by Burt's Multiple Factorial technique using the simple summation method. All the measurements were found to be positively correlated, indicating the presence of a general factor determining the absolute magnitude of each measurement. This is a general factor of size determining variations in bodily size as opposed to bodily proportion.

When the effect of this factor was removed from the table of intercorrelations it was found that some measurements were positively correlated and others negatively. The residual correlations were found to be statistically significant and further analysis revealed a bipolar factor having positive correlation with length measurements and negative correlations with breadth, width and circumferential measurements. This factor determines two contrasting physiques, the relatively long and narrow and the relatively short and broad—corresponding to the linear and lateral types of Stockard (1923) and the "*longiligne*" and "*bréviline*" types of French authors. Factorial analysis therefore demonstrates that there are two main factors responsible for the variations in human physique.

1. Well marked general factor governing growth in all directions.

2. Bipolar factor determining disproportionate growth, preponderantly either in length or breadth.

The findings therefore confirm the existence of tendencies to certain forms of body build in the general population.

The results of the analysis also enable us to discover which measurements correlate most highly with these factors. It was found that suprasternal height and bicristal diameter were most highly saturated with the first factor and stature and transverse chest diameter most highly saturated with the type factor.

Physical typology is a complex subject and the ideal method for its assessment of body type would be the computation of a regression equation of all or many measurements duly weighted according to the type factor. This method is unwieldy as it would involve taking many measurements and carrying out tedious calculations.

For practical purposes it is desirable to have an index containing the least number of measurements compatible with efficiency. In our analysis two measurements were outstanding in their correlation with the type factor, viz.: stature and transverse chest diameter, and they were combined in the following ratio as an index of body build.

$$= \frac{\text{Stature} \times 100}{\text{Transverse chest diameter} \times 6}$$

Transverse chest diameter was multiplied by 6, as stature on the average is about six times as large as transverse chest diameter and multiplying by 100

gives a convenient figure with a mean value near 100. This was the index adopted and was found to be useful in practice. Some would prefer using the ratio :

$$\frac{\text{Transverse Chest Diameter}}{\text{Stature}}$$

as the coefficients of variation of these measurements differ.

For similar reasons some statisticians would advocate the use of standard measure in preference to absolute measure. The use of standard measure makes the index of lesser practical usefulness as it complicates its calculation.

In order to determine whether computation in standard measure was desirable, the index value calculated in absolute measure was correlated with its value calculated in standard measure. The tetrachoric correlation coefficient was found to be $-.04$. This correlation is so high that the more complicated computation by standard measure is not considered necessary.

A similar factorial investigation of female physique has been carried out by the author and the detailed results will be published later. It was found that female body build could not be measured by a simple ratio of measurements and a regression equation of four measurements was calculated by Aitken's method of pivotal condensation (Thompson, 1930) from the results of factorial analysis.

$$\text{Regression equation} = .59 \text{ stature} + .47 \text{ symphysis height} - .31 \text{ chest circumference} - .64 \text{ hip circumference.}$$

Classification of Physical Types.

The question of the existence of physical types has aroused interest in medical and other fields since Hippocrates described two antithetical types—the habitus phthisicus, a narrow type of body build and thought to be associated with susceptibility to tuberculosis, and a contrasting type, the habitus apoplecticus, regarded as having an association with cardiovascular disorders.

Since this time numerous classifications have appeared, such as the digestive muscular and respiratory cerebral types of Rostan (1828); the rachitic, carcinomatous and serophulous-phthisical types of Beneke (1878); the digestive, muscular and respiratory cerebral types of Sigaud (1944); Macrosplanchnic, Normosplanchnic and Microsplanchnic types of Viola (1933); the Pyknic, athletic and leptosomatic types of Kretschmer (1921); Endomorphic, Mesomorphic and Ectomorphic types of Sheldon (1940); and the Leptomorphic, Mesomorphic and Euryomorphic types of Rees and Eysenck (1945). The majority of classifications are based on a dichotomy in physique with two antithetical types as extremes and with intermediate types in some classifications.

If we take the above classifications of physical type as indicating the existence of discrete and mutually exclusive types we find little evidence to support this view when we plot the frequency distribution of various indices among normal and other groups.

Fig. 1 shows the frequency distribution of the Rees-Eysenck index among 1,000 soldiers.

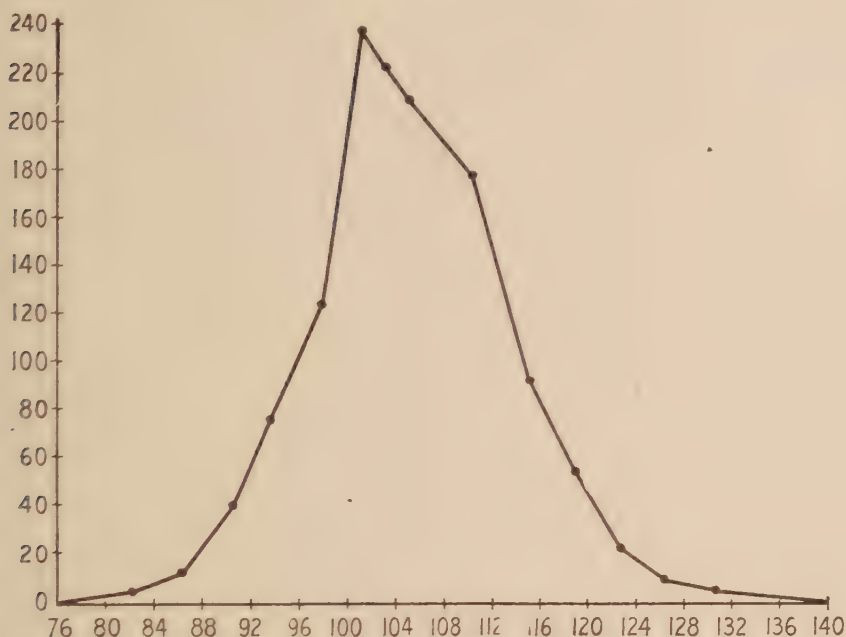


Fig. 1.—Frequency distribution curve of $\frac{\text{Stature} \times 100}{\text{Transverse chest diameter} \times 6}$ index in a group of 1,000 soldiers suffering from neurosis.

It will be seen that the distribution is along a normal curve with some tendency to positive skewness but that there is no evidence of bimodality or multimodality. What we find is a gradual transition from the extreme leptomorph to the extreme eurymorph, that is a continuous variation in physique. The demarcation of physical types is therefore arbitrary and the actual demarcation points taken by us were at one standard deviation above and one standard deviation below the mean.

What we do, in fact, measure by anthropometric indices is a tendency towards certain ranges of body build or the position of the individual in a normally distributed leptomorphic-euryomorphic continuum. This concept emphasizes the futility of using impressionistic diagnosis of physical type for scientific purposes and checking by statistical methods.

Correlation between Various Indices.

Ciocco (1936) pointed out that not only were we ignorant of the principles underlying the construction of various indices but we did not even know the degree to which they correlated with each other.

The calculation of the intercorrelations of various indices is not only of intrinsic interest but in certain circumstances could afford a method of evaluation. Thus, if we could intercorrelate, say 10 different indices taken in a group of individuals, and if these indices were constructed with different measurements, we could carry out a factor analysis on the matrix of intercorrelations. Any significant correlations would presumably be due to a

common factor which should in this case be the factor determining somatic habitus, as this is what the indices were supposed to measure. This factor would correspond to the general factor of factorial studies of intelligence. If factorial analysis revealed a general factor it would be possible to determine the saturations of the various indices with this factor. Those indices having the highest saturation with the factor should be the most valid ones in discriminating physical types.

Thirteen indices of body build were calculated on a group of 100 soldiers. Most of the indices were selected from the list given by Tucker and Lessa (1940) and were chosen because they contained the measurements taken on our group. The list therefore does not necessarily comprise a representative sample and it will be seen that many of the indices are made up of similar measurements—stature and chest circumference are included in many indices and this will result in high correlation between these indices. The fact that stature and chest measurements are common to so many indices certainly influences the resulting correlations and these indices will naturally tend to be highly correlated with the general factor. Thus, the method here cannot be used as a means of validation but only as a means of determining the degree of correlation between various indices.

It will be seen from Table I that the Rees-Eysenck index correlates highly with the other indices with a first factor saturation of .76. The following indices correlate highly with others: Brugsch, Pignet, Stromgren, Wertheimer and Hesketh, Rees and Eysenck, Marburg B. Stature/Sagittal chest diameter

TABLE I.

	Rees-Eysenck Index.	Bornhardt, A. Index.	Marburg, B. Index.	Wigert's Index.	Pignet's Index.	Stature—Sagittal Chest diameter.	Wertheimer & Hesketh (Morphological) Index.	Rohrer's Index.	Brugsch's Index.	Lucas & Pryor's Index.	Martin's Index.	Pignet Ver Vaecq Index.	Stromgren Index.	First Factor Saturation.
1. Rees-Eysenck Index	1	0	.36	.66	.68	.71	.75	.04	.78	.011	0	.76	.81	.70
2. Bornhardt, A. Index	.36	0	.51	.29	.53	.31	.40	.42	.55	.21	.11	.65	.33	.50
3. Marburg, B. Index	.66	.51	0	.44	.66	.62	.66	.22	.64	.34	0	.64	.66	.74
4. Wigert's Index	.64	.29	.44	0	.6	.59	.65	.05	.64	.10	.32	.74	.77	.71
5. Pignet's Index	.68	.53	.66	.6	0	.49	.66	.38	.90	.51	.09	.90	.65	.88
6. Stature ÷ Sagittal Chest diameter	.71	.31	.62	.59	.49	0	.92	0	.67	.09	.08	.60	.8	.74
7. Wertheimer and Hesketh (Morphological) Index	.75	.40	.66	.65	.66	.92	0	0	.73	.12	0	.76	.81	.80
8. Rohrer's Index	.04	.42	.22	.05	.38	0	0	0	.26	.39	.17	.3	.10	.40
9. Brugsch's Index	.78	.55	.64	.64	.90	.67	.73	.26	0	.32	.12	.90	.68	.90
10. Lucas and Pryor's Index	.01	.21	.34	.10	.51	.09	.12	.39	.32	0	.34	.39	.33	.38
11. Martin's Index	0	.11	0	.32	.09	.08	0	.17	.12	.34	0	.17	.38	.20
12. Pignet Ver Vaecq Index	.76	.65	.64	.74	.90	.60	.76	.30	.90	.39	.17	0	.79	.83
13. Stromgren Index	.81	.33	.66	.77	.65	.80	.81	.10	.68	.33	.38	.79	0	.88

and Wigert's index, whereas the indices of Martin, Lucas, Pryor, Rohrer and the Bornhardt A index correlate to a low degree with the others and clearly do not measure the same thing.

Comparison of Indices with Somatoscopic Grading.

The author classified somatoscopically and grouped 100 soldiers into 7 grades according to descriptions given by Kretschmer and others, varying from the extreme pyknic to the extreme leptosome.

Various indices measured independently were correlated with the somatoscopic grading. The Rees-Eysenck index was found to have the highest correlation and had an index of forecasting efficiency of 73 compared with the next best, the Stromgren index which had an index of forecasting efficiency of 42 (Rees and Eysenck, 1945).

Thus the Rees-Eysenck index reproduces the subjective grading of the anthropometric worker more faithfully than other indices, and therefore provides an objective method which can effectively replace somatoscopic grading.

It is not claimed that the Rees-Eysenck index is the most ideal index statistically. As mentioned earlier, a regression equation containing all or most of the measurements would undoubtedly be more accurate, but would be of little value from a practical point of view because of its cumbersome construction and the labour involved in computation.

The ultimate value of any index will be determined by its practical usefulness.

Interesting findings have resulted from the use of the index in the study of personality and neurosis. In an earlier investigation by Rees and Eysenck (1945), a group of 450 soldiers successively admitted to Mill Hill Emergency Hospital were classified by means of the index into leptomorphs, mesomorphs and eurymorphs. It was found that leptomorphs tended to have anxiety, depression and obsessional symptoms, whereas eurymorphs showed a greater tendency to hysterical symptoms. The investigations were extended by the author to a total of 1,100 soldiers and these findings were confirmed.

In a study of effort syndrome, Rees (1943) found that effort syndrome patients, as a group, were more leptomorphic than normal control groups. Furthermore, comparison of leptomorphic effort syndrome patients with euryomorphic effort syndrome patients showed the leptomorphic patients showed greater constitutional predisposition whereas the euryomorphic effort syndrome patients had effort intolerance precipitated usually by extrinsic factors, and was of recent origin as a rule. The leptomorphic patients were of the "constitutional effort syndrome" variety with life-long history of effort intolerance, neuroticism and hypochondriasis.

These interesting correlations between body build and neurosis are not high enough to be of diagnostic value, but indicate the presence of complex inter-relationships between constitutional and extrinsic factors in the development of neurosis and emphasize the importance of taking body build into account in the assessment of total personality in psychiatric illness.

APPENDIX.

Indices of Body Build.

Pignet Index = Stature cm. (chest circumference, cm. + weight, Kgm.)
 Morphological Index is a modification of that of Wertheimer and Hesketh (1926):

$$\frac{\text{Symphysis height} \times 10^3}{\text{Transverse chest diameter} \times \text{sagittal chest diameter} \times \text{trunk length}}$$

Stromgren Index = $-.04$ stature + $.127$ transverse chest diameter + $.56$ sagittal chest diameter.

The following indices are quoted by Tucker and Lessa (1940).

$$\text{Bornhardt, A.} = \frac{\text{Stature} \times \text{chest circumference}}{\text{Weight}}$$

$$\text{Brugsch's Index} = \frac{\text{Chest circumference} \times 100}{\text{Stature}}$$

$$\text{Rohrer} = \frac{\text{Weight} \times 100}{\text{Stature} \times \text{shoulder breadth} \times \text{sagittal chest}}$$

$$\text{Von Rohden} = \frac{\text{Symphysis height}}{\text{Chest circumference} \times \text{anterior trunk height}}$$

$$\text{Lucas and Pryor} = \frac{\text{Bi-iliac diameter} \times 1,000}{\text{Stature}}$$

$$\text{Pignet Ver Vaeck} = \frac{\text{Weight} + \text{chest circumference} \times 100}{\text{Stature}}$$

$$\text{Martin} = \frac{\text{Bicristal diameter}}{\text{Shoulder breadth}}$$

$$\text{Marburg, B.} = \frac{\text{Leg Length}}{(\text{Transverse} + \text{sagittal chest diameter}) \times \text{trunk length} \times \text{shoulder breadth}}$$

SUMMARY.

1. The methods of assessing somatic habitus are discussed, and the principles underlying the construction of various anthropometric indices are considered.

2. The use of factor analysis as an inductive method for providing relevant data for the construction of indices in the form of ratios and regression equations is described.

3. A simple ratio of stature and transverse chest diameter, based on the results of factorial analysis, was used in a group of 1,100 soldiers and no evidence of types in this sense of discrete and disparate categories was found. Body build was found to be normally distributed along a leptomorphic-euryomorphic continuum in which the individual's position can be ascertained by the index.

4. A selection of anthropometric indices, taken on a group of 100 soldiers, were intercorrelated and factorized. For reasons given the method could not be used for validation, but enabled the degree of correlation between various indices to be measured.

5. Correlation with somatoscopic grading showed that the subjective procedure of somatoscopy can be effectively replaced by the objective method of using the index.

6. The use of the index in the study of personality correlations of physique in effort syndrome and other neurotic patients is described.

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NUCLEOPROTEIN IN THE NERVE CELLS OF MENTAL PATIENTS : A CRITICAL REMARK.

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HYDÉN and Hartelius in a recent monograph (1) described nerve cell abnormalities which they consider to be characteristic of mental disease. Their investigations were based on biopsies obtained during prefrontal leucotomy carried out in 11 psychotic patients, 10 of whom belonged to the schizophrenic group. The biopsies were investigated by means of the ultraviolet microscope and the results compared with brain material from normal patients fixed a few hours after death. Two types of abnormal nerve cells were found in the psychotic patients: one type is narrow and shrunken with corkscrew-shaped apical process and appears dark in the photographs in contrast to the other type which is swollen and appears light in the photographs. Both these cells lacked polynucleotides in their cell bodies and contained only a small amount of other protein substances, as shown by the ultraviolet absorption spectra.

Mainly on the strength of this finding the authors instituted a treatment of mental patients with malononitrile, a substance which they consider from experiments on rabbits to stimulate the formation of nucleoproteins in nerve cells.

In view of the interest aroused by the cytochemical work of the Stockholm school in general, the findings mentioned above are bound to have practical repercussions. It is for this reason that we wish to draw attention to the fact that the two cell types described by Hydén and Hartelius in the frontal lobes of psychotic patients can be readily demonstrated in biopsy specimens from the brains of mentally normal patients and normal animals. Greenfield (2) has pointed out how often this biopsy phenomenon has been wrongly interpreted as a pathological change in animal experimental work. A number of biopsy specimens from non-psychotic patients investigated by us a few years ago (3) showed without exception these two types of cells. They were not found in post mortem specimens from one of these patients who died a short time afterwards. This clearly indicates that the changes must have some relation to the conditions associated with biopsy. Whether they indicate the state of activity of different neurons at the time of death as referred to by Greenfield (2) or are merely fixation artefacts (4, 5 and 6), their value as evidence of mental disease is most doubtful.

For technical reasons we have not been able to carry out investigations with the ultraviolet microscope, but the attached illustration demonstrates

that the ordinary Nissl stain clearly brings out the identity of these two types of "cell degeneration" in our biopsy material with those illustrated in the monograph.



The two nerve cell types commonly seen in biopsies of the human cerebral cortex.
Nissl stain. $\times 380$.

Our criticism is directed exclusively against the conclusions drawn from comparison of biopsy and post-mortem material, a criticism of which Hydén and Hartelius were aware but which they dismissed on theoretical considerations. It does not reflect upon the application of the cytochemical method as such to problems of psychiatry.

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ANATOMICAL CORRELATES OF IMPROVEMENT AFTER LEUCOTOMY.*

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OUT of 95 leucotomy cases of which the brains and clinical records have been collected at this laboratory, 45 were cases with post-operative survival of over 5 months, and more than 20 of these showed some degree of clinical improvement. Such numbers now make worth while an attempt to ascertain whether or not any attribute common to the lesions is a prerequisite to clinical improvement; whether or not the degree of improvement tends to vary with any qualitative or quantitative feature of the lesions; and whether or not any such relationship between lesions and improvement which is revealed holds good in equal degree for each of the main types of functional psychosis. Over 20 of the same 45 cases had a recorded post-operative change of personality, so that relationship of post-operative personality change to the leucotomy lesions can conveniently be investigated in the same group of cases. Only some general findings concerning the personality change will, however, be touched on in the present paper.

Apart from previous publications from this laboratory (Meyer and Beck, 1945; Meyer and McLardy, 1947; Meyer, McLardy and Beck, 1948; Meyer and McLardy, 1948) no study at all comparable involving post mortem determination of the actual lesions created, has appeared in the literature. Since some of the cases included in the group under review here have been described in part in previous publications it should be mentioned that minor discrepancies occur between the description of the same case in successive papers due to the continuous recheck of material and extension of histological investigation.

MATERIAL AND PROCEDURE.

Fifty cases were eliminated from the present study on account of post-operative survival of less than 5 months' duration, because such brief survival does not permit reliable evaluation of the clinical results and in practically all such cases undesirable physiological sequelae tend to obscure the picture of the mental state (see Meyer and McLardy, 1948). A further three cases were rejected on account of inadequacy of either the clinical data or the brain material, a fourth on account of severe neurological sequelae obscuring any changes in the mental state throughout a nine months survival period, and a fifth because it was an isolated case of epileptic psychosis. This left 40 cases suitable for investigation of correlations between the lesions and clinical improvement (and personality change).

* This paper was to have been read by A. Meyer to the International Conference on Psychosurgery held in Lisbon from 3rd-7th August, 1948, but owing to unforeseen circumstances could not be presented in full.

For each of these 40 cases the following data were tabulated: serial number, sex, nature of illness, pre-operative duration of illness, previous physical therapy, age at operation, plane of left and right cuts (see Diagrams 1a and b), segments of white matter (see Diagram 2) seen to be involved on macroscopic and microscopic inspection or shown to be damaged from histological study of retrograde cell changes and gliosis in the dorsomedial and anterior nuclei of the thalamus,* nature and duration of post-operative improvement if any,



DIAGRAM 1a.—“M” is the normal plane of cut aimed at in the “blind” operation. The plane tabulated in each case is frequently a mean, for often the final lesion was cystic and frequently it was oblique to the coronal plane.

post-operative personality change (graded roughly for severity as indicated by plus and minus signs), survival period and cause of death. Premorbid personality had perforce to be omitted on account of the inadequacy of its reporting in the majority of case records, most of which were compiled during the war years.

The cases were then divided into the three clinical groups of Predominantly Affective Conditions (Table I), Mixed mainly Paranoid Psychoses with

* This thalamic check was done especially in cases with small lesions situated posteriorly in or close to the anterior thalamic radiation, using the analysis of the cortical projection of especially the dorsomedial nucleus described and illustrated at the International Meeting arranged by the Nederlandsche Vereeniging voor Psychiatrie en Neurologie in 1947 (Meyer, McLardy and Beck, 1948), and since then elaborated by data (not yet published) from a total of 30 hemispheres.

onset after 35 years of age (Table II), and Schizophrenia with onset under 35 years of age (Table III). In each of these three tables the cases were divided into an upper "Improved Group" and a lower "Unimproved Group."

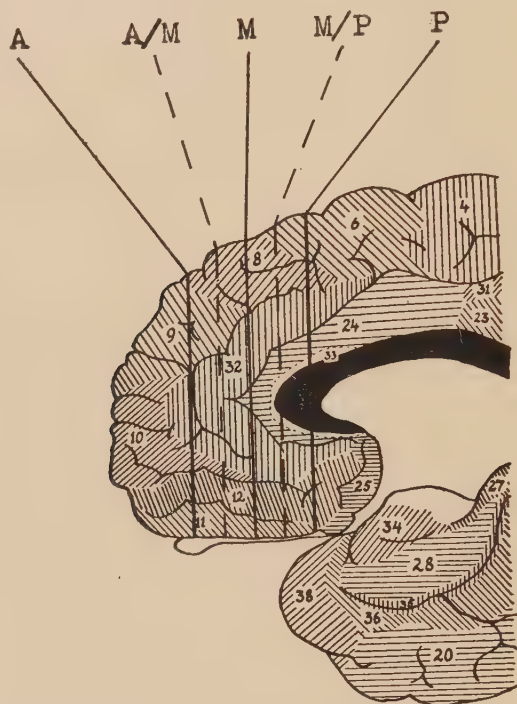


DIAGRAM 1b.—The same planes viewed from the mesial surface of the brain.



DIAGRAM 2.—D, dorsal segment; M, middle segment; V, ventral segment; C, cingulate segment; stippled area, central segment.

The improved cases are arranged roughly in order of grade of improvement. The unimproved cases are listed simply in serial order. The resultant distribution of cases is as follows :

	Improved.	Unimproved.	Total.
Predominantly Affective Conditions	11	4	15
Mixed, mainly Paranoid, Psychoses	6	6	12
Schizophrenias	5	8	13
	—	—	—
Total cases	22	18	40

It should be emphasized that the quality of improvement which is being dealt with here is not representative of improvement after leucotomy in general. The present cases are not a "fair sample" because they are, with few exceptions, cases who never left or lost touch with the mental hospital in which they were treated. If only autopsy investigation could be obtained on a more substantial sample of much improved cases who have died at home or in a general hospital, important information could quickly be derived towards solving the pressing practical problem of the optimum lesions for the optimum result in each type of case. Failing such material, the present less well-improved cases can still be graded among themselves and differentiated from the unimproved in such a way as to reveal, more slowly and laboriously, at least tentative pointers towards any general principles involved.

ANALYSIS.

A preliminary survey of the cases reveals four general points of note :

1. The cases in Tables I and II consist essentially of involutinal illnesses.
2. Three of the Affective cases rank higher in improvement than any of the Mixed Psychoses, of which two in turn rank higher than any of the Schizophrenias, so that from the range of improvement as well as the number of improved cases in each of the groups one would expect any clinico-anatomical correlations to show up most clearly in the Affective Group, least clearly in the Schizophrenic Group.
3. There is no coronal segment which is always bilaterally* involved whenever improvement occurs. The central segment comes closest to being so, if due allowance is made for the fact that a plus in the column for the middle segment often implies only very limited damage by the leucotome entry track.
4. The average total number of segments involved (7.9 out of a possible 10) in the whole 22 improved cases is much greater than in the whole 18 unimproved cases (4.6), involvement of individual segments being relatively highest for the central one.

One general point not demonstrated by the tables is that there was no difference in the quality of the histopathology of the leucotomy scars between the improved and unimproved groups as a whole, appearances in individual cases varying consistently in accordance with the length of time since operation. Another point is that general histological investigation of the unimproved cases showed no evidence of independent organic cerebral conditions which might have militated against improvement.

* Except in enumerating the total number of segments involved, no account of unilateral damage of segments is taken in this paper because of the generally accepted principle that prefrontal lesions must be bilateral to produce physiological or psychological effects.

TABLE I.—*Predominantly*

Serial No.	Sex.	Nature of mental illness.	Pre-op. duration of illness. yrs.	Previous physical therapy.	Age at operation.	Plane of cut.		Segments involved			
						L.	R.	Dors.		Mid.	
								L.	R.	L.	R.
66	F.	Affective psychosis with depression, compulsive thoughts, impulsive outbursts and many hysterical features	2	None	25	M.	M.	+	+	+	+
71	M.	Depression with delusions of poverty and ruin	7	None	63	M.	P.	—	+	+	+
18	M.	Recurrent depression with hypochondriacal delusions and depersonalization.	7	None	66	M.	A./M.	—	+	+	+
10	F.	Impulsive psychopathy with hysterical features including outbursts of rage	4+	E.C.T. Cardz. Insul.	25	M.	M.	—	—	+	+
44	F.	Recurrent agitated depression with hypomanic swings	3	Phren. E.C.T.	43	A.	A.	+	+	+	+
9	M.	Depression with hypochondriacal delusions and depersonalization	4	None	37	M.	M./P.	+	—	+	+
39	M.	Depression with hypochondriacal delusions and strong hysterical features.	3+	None	64	A./M.	A./M.	+	+	—	—
86	F.	Manic-depressive with strong hysterical features and mild hypochondriasis	16	E.C.T.	68	A./M.	A./M.	+	+	+	+
62	F.	Agitated depression with deterioration	3	None	67	A.	A.	—	+	+	+
67	M.	Agitated depression with paranoid delusions and auditory hallucinations during excited phases	7	None	65	A./M.	A./M.	—	+	+	+
78	F.	Manic-depressive with mild paranoid ideas	6	Insul.	35	P.	M./P.	+	—	+	+
35	F.	Agitated depression with vague nihilistic and persecutory delusions	2	E.C.T. Insul.	63	M.	M.	—	—	+	+
46	M.	Recurrent depression with tense feelings of suppressed aggression	3+	Cardz. E.C.T.	50	M.	M.	—	+	+	+
47	F.	Recurrent depression with hypochondriacal features	2+	E.C.T.	42	M./P.	P.	—	—	+	+
87	M.	Agitated depression with delusions of unworthiness	3	None	64	M.	M.	—	—	+	+

Affective Conditions.

Segments involved.			Post-operative improvement.	Post-operative personality change.	Survival period. yrs.	Cause of death.
ent.	Cent.	Cing.				
L. R.	L. R.	L. R.				
+	+	+	Cheerful and free from mental symptoms throughout survival. Discharged to sanatorium after 6 weeks	-	4	Phthisis.
+	+	+	Discharged home cheerful and sl. overactive. Started new job. Sudden relapse during attack of carbuncles	++	1½	CO Suicide.
+	+	+	Became cheerful and lost anxiety about delusional ailments	++	1½	Coronary thrombosis.
+	+	-	Milder, less frequent and shorter outbursts. Discharged home after 1 yr. 8 months.	++	3	Septicaemia.
-	+	+	Ten months normal mood, then relapsed and developed paranoid delus. and aud. hallucinations	+	3½	Phthisis.
-	+	-	Six months' disappearance of delns. and much diminished deprsn., then complete relapse with aud. hallucns.	+	1½	Status asthmaticus
-	+	-	Eight months less worried about delus., then relapse with progressive deteri.	+	1	Purulent bronchitis.
-	+	-	Evening out of mood swings and less tendency to worry	++	11 m.	? Uraemia.
+	+	-	Lost all resistiveness and agitation; slightly less depressed	++	2½	Carcinoma of uterus.
+	+	-	Less depressed; noisy outbursts greatly reduced in frequency and duration	++	2	Carcinoma of pancreas.
-	+	-	More even in mood until death	+	5½ m.	Phthisis.
-	-	-	None	-	1	?
-	+	-	Normal mood for three weeks, then complete relapse	?	½	CO Suicide.
-	-	-	One month very cheerful then relapsed rapidly and deterd. during terminal yr.	+	3½	Carcinoma of cervix.
-	-	-	One month less depressed and agitated, then complete relapse	?	1½	Lung abscess.

TABLE II.—*Mixed, Mainly Paranoid, Psychoses*

Serial No.	Sex.	Nature of mental illness.	Pre-op. duration of illness, yrs.	Previous physical therapy.	Age at operation.	Plane of cut.		Segments involved			
						L.	R.	Dors.		M.	
								L.	R.	L.	M.
65	M.	Paranoid psychosis with visual and auditory hallucinations and outbursts of violence; no deterioration	5	E.C.T.	56	P.	P.	+	+	+	
37	F.	Paranoid psychosis with aud. hallucns., grandiose delusions and violent outbursts; gross deterioration	13	None	62	M.	P.	-	+	+	
64	F.	Paranoid psychosis with outbursts of maniacal excitement; no deterioration	3	Cardz.	44	A./M.	M.	+	-	+	
14	M.	Paranoid psychosis with visual and auditory hallucns. and manic-depressive swings; no deterioration	9	E.C.T.	54	M.	M./P.	-	-	+	
75	F.	Paranoid psychosis; negativistic, suspicious, autistic; no deterioration	2	Insul.	39	A.	A./M.	+	-	+	
90	M.	Paranoid psychosis; no deterioration	3½	E.C.T. Insul.	37	M.	M.	-	-		
20	F.	Paranoid psychosis with some alternating stupor and excitement; no deterioration	5	E.C.T.	47	A./M.	A./M.	+	-	+	
21	M.	Paranoid psychosis with hallucinosis and manic-depressive features; no deterioration	13	None	61	M.	M.	-	-	+	
26	F.	Paranoid psychosis with hallucns. and impulsive outbursts; no deterioration	1	E.C.T.	44	P.	P.	-	-	+	
27	F.	Paraphrenia (delusions of reference, aud. hallucns., violent outbursts and grandiose features; no deterioration)	2	None	54	P.	P.	+	+	+	
38	F.	Paranoid psychosis with some alternating stupor and excitement; no deterioration	10	None	68	P.	M.	-	-	+	
74	F.	Paranoid psychosis with impulsive outbursts and manic depressive features; no deterioration	4½	None	54	A.	A./M.	-	-	+	

With Onset Over the Age of 35.

Segments involved.					Post-operative improvement.	Post-operative persity. change.	Survival period.	Cause of death.
Ant.	Cent.		Cing.					
R.	L.	R.	L.	R.			yrs.	
+	+	+	-	-	More tractable and employed more usefully throughout survival. Hallucinations became inconspicuous. Granted parole	++	3	Lobar pneumonia.
+	-	+	-	+	One year less aggressive. Lucid intervals (with E.C.T.) and cleaner until death.	?	4½	Lobar pneumonia.
+	+	+	+	-	Quiet and well-conducted with no evidence of delusions for 9 months, then complete relapse	+	2	Chronic nephritis.
+	-	-	-	-	Four months normal mood and loss of hallucinations, then complete relapse with profound depression	?	8 m.	?
-	+	-	-	+	Two months more sociable; 9 months less hostile, then relapsed into pre-operative state	++	3	Phthisis.
-	+	+	-	-	Slightly less evidence of delusions of persecution for 2 years, then became worse, with aggressive outbursts and auditory hallucns.	-	4½	Duodenal ulcer.
-	+	-	+	-	Co-operative and brighter for 3 weeks, then gradually relapsed and deteriorated	+	2½	Lung Gangrene.
-	-	-	-	-	Two months slight improvement, then full relapse	?	1½	Cardio-vasc. degeneration.
-	-	-	-	-	Six weeks quiet and friendly, then complete relapse	?	3½	Pneumonia.
-	+	-	+	-	Four months very slightly less aggressive, then relapsed and deteriorated.	?	3½	Circ. failure.
+	-	-	-	-	None	+	1½	?
+	+	+	-	-	One month moderately well conducted, then relapsed and slowly deteriorated	+	3½	Carcinoma of oesophagus.

TABLE III.—*Schizophrenia With*

Serial No.	Sex.	Nature of mental illness.	Pre-op. duration of illness, yrs.	Previous physical therapy	Age at operation.	Plane of cut.		Segments involve		
						L.	R.	Dors.		Mic.
						L.	R.	L.	R.	L.
57	M.	Paranoid schizophrenia with hysterical features; no deterioration	1	Cardz.	23	M.	M.	+	-	+
61	F.	Paranoid schizophrenia: impulsive; unemployable; no deterioration	7	Insul. E.C.T.	37	M.	M.	+	+	+
94	F.	Paranoid schizophrenia with delusions of reference and auditory hallucinations; violent; hysterical element; no deterioration	2½	Narcos. Insul. E.C.T.	22	M./P.	M.	+	+	+
60	F.	Schizophrenia with delusions of sinfulness and prominent obsessional symptoms; slight deterioration	4+	Insul. E.C.T.	24	M.	M.	+	+	+
63	F.	Catatonic schizophrenia with delusions of persecution and auditory hallucinations during excited periods; considerable deterioration	20	None	47	A./M.	M.	+	+	+
5	M.	Catatonic schizophrenia with grandiose and persecutory delus. and aud. hallucs. during excited phases; deteriorated	20	None	43	A.	A.	+	+	+
12	M.	Catatonic schizophrenia with grandiose delus. and aud. halluc. during excitement; severely deteriorated	12	Cardz.	32	A.	A.	+	+	+
19	M.	Catatonic schizophrenia with many delusions and aud. hallucs., deteriorated	21	None	51	M.	M.	-	-	+
31	M.	Paranoid schizophrenia with aud. hallucs.; autistic, mildly depressed; no deterioration	25	None	50	P.	P.	-	-	+
36	F.	Schizophrenia with violent outbursts; severely deteriorated	3+	?	35	M./P.	P.	-	-	+
69	F.	Schizophrenia with delus. of reference, auditory halluc. and catatonic features; severely deteriorated	11	None	37	M.	M.	+	-	+
81	F.	Hebephrenic schizophrenia; inaccessible for last 3 years; deteriorated	18	None	47	P.	M./P.	+	-	+
85	F.	Hebephrenic schizophrenia; no deterioration	9	E.C.T.	30	M.	A.	-	-	+

set Under the Age of 35.

Segments involved.			Post-operative improvement.	Post-operative persivity, change.	Survival period. yrs.	Cause of death.
t. R.	Cent. L. R.	Cing. L. R.				
+	+	+	Discharged 5 weeks after operatn. Absence of delus. of persecutn. while living and working away from home for 1 yr. Then almost com- plete relapse	++	2½	Hypoglycaemic coma.
+	+	-	More amenable, less disturbed by his delusions and occu- pied making toys through- out survival	+	1½	Sub. bacter. endocarditis.
+	+	+	Four and a half months clear of delus., 6 months' relapse; 9 months moderate recov- ery, then severe relapse until death 10 months later. Discharged during remis- sions	+	2½	Broncho- pneumonia.
+	+	+	Slightly less evidence of com- pulsive ideas for 4 months then complete relapse	+	3½	Electro- narcosis.
+	+	-	Two and a half months well behaved, showing sense of humour and occupied in handicrafts, then relapsed completely	+	1½	Chronic phthisis.
+	+	+	None	+	1½	Status epilepticus.
-	+	+	None	+	2	Phthisis.
+	+	-	None	+	½	? Uraemia.
-	+	-	More reserved and shy than ever	-	1½	Myocard. degeneration.
-	-	-	None	?	2	?
+	+	-	None	+	2	Phthisis.
+	+	-	None	++	1½	Myocard. degeneration.
-	-	-	None	?	1½	Second leucotomy.

Any further gross comparison of the whole 22 improved cases with the whole 18 unimproved cases is unprofitable in view of the divergencies in findings between the different clinical types of cases. Further analysis has therefore been carried out by clinical groups.

Predominantly Affective Conditions. (TABLE I).

On the clinical side the only conspicuous difference between the improved 11 and the unimproved 4 is that a much larger proportion of the former, including the three best improved, had not had the benefit of previous physical therapy.

On the anatomical side the most striking difference between the improved and the unimproved is the much higher average total number of segments involved in the former (6.7) than in the latter (2.8). If one discounts the middle segment for the reason given above, this higher frequency is seen to hold for bilateral involvement of each of the segments, but in different degrees. It is most marked in the central segment, somewhat less in the ventral, still less in the dorsal and least in the cingulate segment, where in fact the damage is only twice bilateral (and actually on both sides in each case involves only area 32 and not area 24). Within the improved group the better improved have, on the whole, more posterior and fuller cuts. Another feature is that the four best improved have bilateral involvement of the ventral segment.

The cases in the unimproved group would indicate that bilateral superficial damage to the white matter (and cortex) of either area 45 (Nos. 35, 46 and 87) or the insula (No. 47) is insufficient to cause more than transitory improvement in what are generally agreed to be favourable types of case for leucotomy.

Mixed, Mainly Paranoid, Psychoses with Onset Over the Age of 35.
(TABLE II).

No suggestive trend is discernible in the incidence of any of the clinical data of recognized prognostic value. The only anatomical differences of note between the improved 6 and the unimproved 6 is the slightly higher average total number of segments involved and the very appreciably higher frequency of bilateral involvement of the central segment in the former. Within the improved group there is again, as in the Affectives, a tendency for the better improved to have more posterior and fuller cuts. Two of the three best improved cases have bilateral involvement of the ventral segment.

No. 26 in the unimproved group would indicate that bilateral interruption of substantial numbers of fibres coursing through the external capsule is insufficient to cause more than transitory improvement in a prognostically favourable type of case.

Schizophrenia with Onset Under the Age of 35. (TABLE III).

In this group there is a major clinical difference between the improved 5 and the unimproved 8, in that the latter contain wholly chronic and mostly deteriorated cases while the former contain only one such. This, together with the low grade of improvement, renders it of very dubious value to observe

that the improved cases have in general a more extensive isolation of prefrontal cortex when the plane of the cuts and their extent are considered together, or to note that of the individual segments those with notably higher frequency of bilateral involvement in the improved group are the ventral and dorsal segments. In the four cases with bilateral involvement of the cingulate segment the damage extended into area 24 on each side in all except case No. 94.

Personality Change.

A feature not very readily appreciated from Tables I-III is that there is a strong suggestion of relationship between the severity of post-operative personality change and certain of the segmental data listed. A separate analysis of all cases where the recording of the personality change can be accepted as probably reliable is summarized in Table IV* and shows clearly

TABLE IV.—*Summarized Analysis of the Lesions in Relation to Different Grades of Post-operative Personality Change.*

Post-operative personality change.	Segments of white matter involved in the leucotomy lesions.						Average total segs.
	Bilat. dors. seg.	Bilat. mid. seg.	Bilat. vent. seg.	Bilat. cent. seg.	Bilat. cing. seg.		
++ (11 cases)	19%	100%	73%	91%	9%		7.2
+ (10 cases)	40%	80%	40%	60%	10%		5.5
- (14 cases)	14%	86%	7%	21%	0%		3.4

that the severity of the change tends to vary directly with the total number of segments involved, and particularly with bilateral involvement of the central and ventral segments. The more detailed analysis of anatomical correlates of personality change is described and discussed by the present writers in a separate paper (Meyer and McLardy, in press).

DISCUSSION.

Although the difference is outstanding only in the Affective group, there is in each of the clinical groups an appreciably higher average total number of segments involved in the improved cases than in the unimproved ones. In the Affective and Mixed groups this principle likewise obtains between the best improved and the less well improved cases, and in addition the best improved have, on the average, more posteriorly† placed cuts. When cognizance is taken of the fact that most of the improved cases had only very moderate prognostic potentialities, all these findings seem to point clearly to one general principle, namely that clinical improvement in such circumstances varies directly with the total amount of prefrontal cortex isolated from its connections.

At the same time the figures point to the fibres which run in the central segment as being those whose cutting matters most of all, at least in affective and mixed paranoid conditions. This would still be in conformity with a

* The case of epileptic psychosis is included in this Table.

† It should be borne in mind that by the method of selection practically all cases with bilateral involvement of premotor or posterior orbital cortex or the basal ganglia have been excluded from this study.

quantitative principle, since thalamic fibres to and from all other segments tend to collect in this central region. Its full involvement in a posterior plane will sever most fibres coursing between the thalamus and prefrontal cortex. In progressively more anterior cuts the fibres travelling in it will become progressively more only those connecting with regions near to the frontal pole (areas 10, 46 and anterior parts of areas 9, 11, 12, 47 and 32). In cuts at a middle plane (i.e. the commonest plane of cut in the best improved cases in this series) such rostrally connected fibres will already constitute a high proportion of the fibres in the central segment. This is of considerable interest in the light of recent American clinical reports such as the preliminary one by Heath and Pool (1948) where substantial improvement occurred in two psychotic cases after cortical resection limited to dorsal parts of areas 10, 46 and 9, and Freeman's (1948*b*) report of a high rate of favourable response in over a hundred cases (including early schizophrenics) after transorbital lobotomy which he considers isolates essentially these same regions of cortex. Whether this simply means that in more suitable, especially earlier, cases than most of the present series, cutting off the poles happens to represent the optimum amount of isolation of prefrontal cortex, or whether a more specific factor comes in, cannot as yet be decided.

Heath and Pool and Freeman, as mentioned, attribute special therapeutic significance particularly to the dorsal aspect of the rostral region. The present analysis, of admittedly still limited material, would tend to put emphasis rather on its orbital aspect. The five best improved cases (Nos. 66, 71, 18, 10 and 65) in the whole series, for instance, have all bilateral involvement of the ventral segment. Nevertheless, within the present series there are several instances of considerable improvement where the bulk of the orbital white matter was completely spared, and Freeman and Watts (1947) describe a case of involutonal melancholia where spectacular improvement followed lesions which almost entirely spared the orbital regions.

A further point of interest is the negative one that finer anatomical analysis, not recorded in the tables, shows that in no instance within the whole series of 40 cases did the ventral lesion encroach upon the agranular cortex in the postero-medial part of the orbital region (Beck, in press) which probably contains cortex homologous to the monkey's area 13, which is known to be closely related to autonomic function.

The few instances of bilateral involvement of area 24 suggest that it is only this part of the cingulate segment which entirely fails to correlate with improvement. This disaccords with Ward's (1948) suggestion, derived from work on animals, that ablation of area 24 might benefit psychotic patients, and so tallies with recent American experience (W. Freeman: personal communication) which tends to show that bilateral circumscribed ablation of area 24 has no ameliorative effect, and actually severe physiological consequences. Whether the bilateral damage to area 24 might explain the unusually poor response to full cuts in a strongly obsessional patient such as Case 60, must remain conjectural until more such material has been investigated.

The clinical factors which have been remarked upon, and doubtless others not recorded, no doubt also play their part in improvement (and its absence)

in this series and may be the most important prognostic factors in a few of the cases. So little detail is known of the premorbid personality in the majority of the cases that it is futile to search for any relationship with improvement. No valid comment based on this material can therefore be made on Stengel's (1948) impression that improvement depends materially on the maturity of the premorbid personality.

The post-operative personality change in this series of cases would appear to have the same anatomical correlates as has the clinical improvement, except that it is perhaps related still more strongly to bilateral damage to the ventral segment. Hence one would expect, and there is, in the series a high correlation of personality change with improvement. This of course does not necessarily imply that the personality change causes the improvement, although in fact such a tentative conclusion was come to by Frankl and Mayer-Gross (1947) from clinical observations. Whether the positive correlation with involvement of the ventral segment is significantly higher for personality change than for improvement is too fine a point to be determined from the unsystematic clinical observations available in this series of cases, but certainly it has for long been held that the orbital region is peculiarly related to at least the euphoric type of personality change. Close attention will continue to be paid to this important practical matter in further studies.

The most general result that comes out of the present study is therefore that the gross amount of isolation of *prefrontal* cortex from its white matter is an important correlate of clinical improvement (and personality change) after prefrontal leucotomy. This result, it should be emphasized, is derived from, as a whole, poor clinical material. In cases of better prognostic potentiality than in the majority of the present series more circumscribed and more rostral lesions may well constitute the optimum amount of damage. Heath and Pool's and Freeman's results seem to confirm that in fact such is the case. These authors suggest further that a principle of selective localization applies to such minimal lesions. They emphasize importance of dorsal parts of the rostral cortex. The tentative results of the present analysis would point rather to the ventral parts of the rostral cortex being the more important, at least in affective and mixed psychoses. From the descriptions and illustrations given in Freeman's papers (1948*a, b*) one gains the impression that, contrary to his own emphasis, transorbital leucotomy actually cuts more ventral than dorsal fibres.

SUMMARY.

(1) There is strong evidence that, in at least predominantly affective conditions and mixed mainly paranoid psychoses, improvement varies, among cases of equally moderate prognostic potentiality, directly with the amount of prefrontal cortex isolated from its white matter. The same tendency was observed in the schizophrenias, but owing to their low level of improvement and the lack of suitable unimproved cases for contrast no reliable trends could be derived from those in the present series.

(2) No evidence is found of any segment of white matter the bilateral involvement of which is indispensable to improvement. The central segment

comes nearest to being such a region. This may still be simply an expression of the general quantitative principle. Since, however, at the commonest level of effective leucotomy cuts in this series the central segment contains a high proportion of fibres connecting with the more rostral regions of prefrontal cortex, the finding does not contradict recent evidence, derived from selected cases with better prognostic potentiality than most of the present series, of good results after circumscribed resection or (transorbital) leucotomy—with the qualification that the present analysis points to rather greater importance of the orbital than of the dorsal aspect of the rostral regions of the cortex.

(3) There is no evidence that bilateral involvement of area 24 or of the agranular part of the posterior orbital region contributes to improvement: on the contrary it seems if anything to militate against improvement.

(4) The anatomical correlates of post-operative personality change would appear to be roughly the same as those of post-operative improvement, with perhaps some additional emphasis, in the former, on isolation of orbital cortex.

ACKNOWLEDGMENT.

Grateful acknowledgement is made to all those throughout the country who sent the brain material for investigation and gave generous access to the clinical records.

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TRANSORBITAL LEUCOTOMY.

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AND

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THE operation of transorbital leucotomy recently described in the *Lancet* by Freeman (1948) was originally devised and carried out by Fiamberti in 1937 very soon after Moniz had introduced the original operation of leucotomy. Meyer, Beck and McLardy (1947) have shown that degeneration of the central portion of the pars parvicellularis of the dorso-medial nucleus of the thalamus was correlated with a lesion involving areas 9, 10 and 46 in the middle frontal gyrus. The transorbital method might now be said to follow almost logically on the work being done at the Columbia Presbyterian Medical Center and at the Greystone State Hospital, New Jersey, by a team of 96 (!) collaborators. Brodmann areas 9 and 10 and in some cases part of area 46 of the cerebral cortex are removed by an open bone-flap operation. This work is still in its infancy, and is not yet published apart from a summary by Nolan Lewis (1948). The entire project is to be described in a volume, *The Human Frontal Lobe*, to be published at an early date.

Heath and Pool (1948) reported bilateral resection of areas 9 and 10 in four cases using pentothal and then nitrous-oxide oxygen. The operation averaged five and a half hours, compared with the fifteen minutes or less (even 7.5 minutes !) required by the ordinary leucotomy. No complications developed, and there was no post-operative period of apathy or retardation so often seen after leucotomy. Two of the four cases made a social recovery.

Freeman found that there was less disturbance of the personality after transorbital leucotomy ; there was only occasionally the indolence and tactlessness found after leucotomy. (The post-operative disturbance is not nearly so severe as after leucotomy, and in the case of female patients the fact that the head has not to be shaved at all is a great advantage.) In some cases there was a period of elation followed by a return of symptoms and then a slower and steadier improvement. He also thinks that transorbital leucotomy renders patients more responsive to electro-shock therapy. The most striking change he noticed was an increased friendliness and sociability, due to the removal of emotional tensions. Fixed delusions and hallucinations are rather resistant to treatment, and motor compulsion and tics are little affected.

Severe emotional dilapidation is the most outstanding contra-indication to the operation, with schizophrenic psychoses of long-standing next in importance. The obvious conclusion from the success of removing areas 9 and 10 is to try

and undercut these areas, and so do without the lengthy operation of more than five hours. Fig. 1 shows the area of cerebral cortex removed, and Fig. 2 the position of the cut made by transorbital leucotomy underneath these areas,



FIG. 1.—Showing area of cortex removed by topectomy.



FIG. 2.—Showing area destroyed by transorbital leucotomy.

and so severing many of the fibres running to the median nucleus of the thalamus.

Freeman found, after operating on more than 100 cases by the transorbital method, that the results were much the same as after the better known opera-

tion of prefrontal leucotomy. He found a rapid recovery in a number of cases which had not responded to intensive electric-shock treatment and other more conservative measures. So far his mortality-rate has been *nil*, as against an average mortality in leucotomy of about 3 per cent. He does not give any figures as to the occurrence of epileptic fits after the operation. The neurosurgeon purist will no doubt expect a higher rate of epilepsy after an instrument has been driven through the orbital plate, with the consequent risk of spicules of bone being raised and of small adhesions forming between the dura mater and the cerebral cortex. The risk of infection would appear to be small. Freeman does not report any cases, and in our small series we have met none. All cases as a prophylactic are given sulphadiazine 4 grm. in four separate doses before the operation and again after it.

		Age.	Duration of illness.	Date of leucotomy.	
E. M. P—	Depression	57	2 years	5.x.48	Improved.
D. M—	"	55	4 "	28.x.48	Recovered.
M. W. G—	"	62	6 "	13.x.48	Improved
E. A. C—	"	75	1 year	13.x.48	"
F. A. W—	"	73	4 years	17.viii.48	"
H. G—	Paranoid schizophrenia	47	1 year	31.viii.48	Recovered.
R. M. H—	Ditto	43	6 years	22.vii.48	Improved.
A. L. W—	Catatonic	33	4 "	22.vii.48	Worse

The technique followed in our eight cases was personally demonstrated and has been published by W. Freeman (1948).

Where possible, the position of the leucotome inserted to its final depth of 7 cm. has been checked by lateral X-rays before extraction of the instrument, and this has been found to correspond with the line of the coronal suture, though constant alignment needs some practice. Some varying degrees of resistance have been encountered in piercing the bony roof of the orbit. It was likely in at least one case that the outer angle of a large frontal sinus was penetrated, and this has been demonstrated in practice on a cadaver. The hazard of infection is obvious, and although no such complication has been recorded, it is considered advisable to have a preliminary X-ray to exclude active nasal sinusitis. It has been found extremely difficult to avoid contamination of the leucotome by the lid margins. These may be protected by a self-retaining eyelid retractor. (Pre- and post-operative sulphonamide has been adopted as a prophylactic measure.)

The danger of serious damage to intracranial blood-vessels with this "blind" operation appears to be small, as the orbital surface of the frontal lobe is relatively avascular. However, intravenous pentothal anaesthesia was used in place of electroconvulsive shocks in two cases with vascular hypertension, because of the increased risk to cerebral vessels with post-convulsive congestion. Freeman comments on the possibility of damaging deep vessels if the leucotome is moved too far—a risk also present and doubtless greater, of course, with major leucotomy.

CONCLUSIONS.

Of the 8 cases, 2 have recovered completely and very quickly, 4 of the depressed patients are very much better, 1 schizophrenic of long standing is much improved and the other appears to be worse.

All of these cases were of bad prognosis, and 7 out of the 8 have shown improvement varying from apparent recovery to distinct improvement.

From a surgical point of view 2 could not have been operated on by ordinary leucotomy without great risk.

The cases described as improved have shown great improvement, but are not yet considered well enough to go home.

CASES.

E. M. P—, aged 57, widow, housewife. Had been depressed for some time. E.C.T. as an out-patient early in 1947, and subsequently admitted in December for some more. After a further 12 fits she was allowed to go home for domestic reasons. She slowly lost ground again, and was seen and the question of a leucotomy discussed with her. She agreed to have it done, and came into hospital on 2.x.48. There was nothing abnormal physically; blood pressure 136/86. She was very depressed, worried, and said she regarded leucotomy as her only hope.

5.x.48: Transorbital leucotomy under E.C.T. She developed a marked tachycardia afterwards, but otherwise her post-operative course was uneventful. After three days said she felt perfectly well and ready to go home and do her housework. At times a little emotional and inclined to cry.

D. M—, female, aged 55, single, housekeeper; one of nine children; one brother died in Winson Green Mental Hospital in 1924. Described as hysterical and stubborn. Lived with and looked after a very domineering old mother from the age of 25 until she was 51. She then became depressed and complained of noises in her head and insomnia; became untidy when she had previously been very tidy. During the past four years has had E.C.T. always with extreme cyanosis. Whilst at home she has made three attempts at suicide with sleeping tablets, and before admission 9.iii.48 was found unconscious again, having taken an overdose of sleeping tablets. Slowly improved, but began to relapse and become depressed, continually talking about the unhappy years she spent with her mother.

On 28.x.48 transorbital leucotomy under E.C.T. Post-operative course uneventful. Showed considerable confusion for first few days—wanted to “let air out of her hot water bottle” and succeeded in flooding her bed. Improved very quickly after this and became cheerful and bright, saying that she had not felt so well for years and that life at last was a pleasure.

M. W. G—, aged 62, single, physiotherapist; one of seven children. An aunt had “bouts of depression.” Was always highly strung and suffered from migraine. Gave up work in 1929 as too exhausting. Had a nervous breakdown in 1945, was depressed and could not sleep. During next three years had treatment in several nursing homes and hospitals, including courses of E.C.T. on two occasions. Condition varied, but little progress, and was admitted to Barnwood House 20.ix.48 for leucotomy. On admission there was little to be found abnormal on physical examination, except a blood pressure of 220/130, which would ordinarily rule out any question of leucotomy as much too dangerous. The patient was depressed and agitated, complained of great loss of power of concentration and inability to think. Continually picking her face.

13.x.48: Transorbital leucotomy under pentothal anaesthesia. No post-operative complications. Still depressed and agitated and still picking her face. Had to be catheterized on three or four occasions during the ensuing fortnight. The systolic blood pressure came down to 150 on 6.xi.48. Became wet and remained so until 23.xi.48. Has continued to improve steadily, gaining weight, and has reached the stage of “going to dances.”

E. A. C—, female, aged 75, widow; no family history of insanity. Had always been of a depressive type, and for past few months had shown depressive symptoms—querulous and fault finding, agitated, asked if someone could give her a dose of poison.

30.ix.48: Admitted to Barnwood House. On examination showed no physical abnormality except very severe arterio-sclerosis and a blood-pressure of 196/96. Says life is quite hopeless and that she cannot recover; is depressed and agitated, and wants to be poisoned. Again not a case for ordinary leucotomy.

13.x.48: Transorbital leucotomy under pentothal anaesthesia. Returned from Bristol in a cheerful mood and with no discomfort. Was confused for a few days, but no incontinence. When the confusion disappeared was still rather depressed but not agitated, and smiled when asked about having some poison. Took an intelligent interest in things going on around her, and quite astonished her relatives when they came to see her. Discharged.

F. A. W—, female, aged 73, widow; no family history. Had been confused for some time; wandering round her house saying "Oh!" at frequent intervals, unable to answer questions or give a connected account of herself. She was admitted to Barnwood House as a temporary patient 14.vii.45. She made no progress and was certified on 25.x.45 as she was deemed to have regained volition, but was still very depressed and agitated. She remained in this depressed state. Her physical condition was not good; she had a considerable degree of arterio-sclerosis, but her blood-pressure was only 112/76.

17.viii.48: Transorbital leucotomy under pentothal anaesthesia. Post-operative course uneventful. Was somewhat confused for two or three days, but very much more cheerful and less agitated. She then became more depressed for a while, but this slowly disappeared.

H. G—, female, aged 47; single, manageress in big store; one of five children. A brother stated to have a "nervous disorder." Has always been introspective, and was regarded by the rest of the family as the "odd" member. No interests outside her work. Was "engaged" at 24, but fiancé proved to be married; this made her very bitter. Had a previous nervous breakdown in 1938-39 and was treated by her family doctor at home. Menstruation always difficult and ceased at 46. Six months before admission had a skin affection of her feet, which was treated by a competent dermatologist; she insisted it was syphilitic. Was vague in conversation and brooding—had ideas of persecution and said that she was trapped. This slowly progressed. She said that wireless was used to read her thoughts, that her employers were trying to spy on her and dismiss her (not true). She looked old, worn and morose. She was untidy and careless in appearance and habits. Became difficult to deal with, then said she wanted to die—that there was nothing left to live for. Was deemed suicidal and was admitted as a voluntary patient. On admission she was found to be hallucinated, but otherwise would not say much about her illness. Thought the other patients were in telegraphic communication with her; one day said she had been cut in half. Became very depressed and wandered out of the garden, so it was decided to perform a leucotomy on her.

31.viii.48: Blood pressure 160/100. Transorbital leucotomy performed after five successive electric fits. Her post-operative course was quite uneventful; she said she felt calm and contented, and was not worrying. She continued to improve, her hallucinations had gone and she became cheerful and friendly. On 18.ix.48 she left hospital and went to stay with relatives in London. Her family doctor expressed the opinion that he was amazed at the change in her.

On 1.xii.48 was seen and appeared to be happy and contented; in good physical health.

R. M. H—, female, aged 43, married. Paternal aunt said to have had a mental breakdown. Has always been of a worrying disposition, lacking in self-confidence and over-conscientious. Mental breakdown started in India in 1942. During the following five years had a variety of treatments in Ranchi European Mental Hospital—cardiazol, sulfosin, E.C.T., hydrotherapy, insulin coma with 52 comas, more E.C.T., clinstrol and seconal. Was a typical catatonic—mute, negativistic, had to be nasally fed, was violent, aggressively sexual in behaviour, masturbating fre-

quently; mechanical restraint had to be resorted to. Improved considerably after the insulin comas, but still restless and idle. Dirty in her habits. Flown to England in June, 1948, and certified.

25.vi.48: Admitted to Barnwood House. Resisted any attempt to examine her, but talked quite pleasantly to nurses and doctors. Was employed doing needlework, which she does very well and concentrates on quite well. Habits *not* dirty. Expression always puzzled and always "wanting to go over there." Cannot be persuaded that she is in England.

22.vii.48: Transorbital leucotomy after E.C.T. Post-operative course uneventful; no incontinence. For a few days she was brighter and wrote letters to her parents and sister, a thing she had not done for a long time. Doing needlework again, but still puzzled and somewhat unhappy at times. Subsequently continued to improve and has been allowed home for the day.

A. L. W—, female, aged 33, single; no family history. Previous to admission had had treatment in other mental hospitals. Admitted 17.xii.45; a typical schizophrenic, foolish in behaviour, laughing, grimacing and unable to sustain a connected conversation; volunteered the information that "she was not right in the head."

22.vii.48: Transorbital leucotomy after E.C.T. No post-operative complications; not faulty. Subsequent course rather stormy—became excitable and banged her head against wall, causing a large haematoma; removed to padded room. This excitable state continued for two months or more, and then slowly subsided.

Our thanks are due to Prof. F. L. Golla for the use of the facilities provided by the Burden Neurological Institute, where all the operations were carried out.

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CHESS AS A FORM OF RECREATIONAL THERAPY.

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ALTHOUGH chess sets are usually to be found in the games cupboards of the male wards of a mental hospital, it is a rare sight to see two patients indulging in this game. Nevertheless, it may be a humiliating experience for any medical officer to challenge a patient to a match unless he is a fairly good player.

How is it, then, that such an enjoyable indoor pastime is not more frequently played in institutions where time is plentiful and where cross-word puzzle addicts are seen in plenty? Surely the intricacies of chess should have a special appeal for those whose minds are absorbed with abstract problems, particularly schizophrenics. The fact is that this appeal is very strong, but the schizophrenic is by nature unsociable, and may prefer to work out imaginary games by himself or solve the problems found in newspapers. There are no organized chess "drives" for him to meet other players, and even if an opponent is found, there could be little pleasure in persistently winning or losing against the same adversary.

Although I have suggested that chess is a game for schizophrenics, the idea of having a patients' chess team was evolved after several unsuccessful attempts on my part to defeat a case of recurrent mania, who for many years had been regarded as invincible. If no one in the hospital could defeat him, then someone outside had to be found who could. He was therefore taken to the Lancaster Chess Club and introduced to the "top board" player. He lost, but was put in the City team and played for them regularly throughout the season. In the meantime our games, which were played in the open ward, had aroused considerable interest among the bystanders; several other players were discovered, and new players were taught by the experts. Moreover, the frequent appearance of Mr. A—'s name in the local paper stimulated a hunt for further talent.

In due course a match was arranged between an "A" team from the City club and eight patients. The result was a draw (4 wins each), and the evening, which was concluded with food, tea and speeches, was a social success.

It was now obvious that such matches had to continue, and I seldom passed a party of male patients in the grounds without being plagued by the question of "When's the next match?" Fortunately the City of Lancaster possesses several organizations (clubs, factories, etc.) having their own chess teams, and matches were not only played "on the home ground" but also "away." The latter were very popular with the patients, who enjoyed the outing as much as the games themselves, especially on one occasion when our hosts provided beer instead of tea!

During the last winter season there were ten matches played against outside clubs. Two of these were won by teams consisting of eight or nine patients, but when the number of players increased to fourteen, the team as a whole

was found to be weaker on account of the large "tail" of mediocre players. In the final match, however, against a teachers' training college, we played a side of seventeen, which included three medical officers, and obtained a draw ($8\frac{1}{2}$ points each).

There were also inter-ward matches and knock-out competitions at Xmas time, but in addition to organized chess, there was regular play almost daily in the parole ward, with often three sets in use at the same time.

Up to the present no attempt has been made to introduce chess on the female side, as the game is not generally popular with women. I have, however, played several games with a female paraphrenic who was quite good until she deteriorated.

In the table are included the bare essentials concerning patients who have won at least two of their individual match games against normal opponents. These results demonstrate that a few good players may be found among chronic cases of long duration, especially schizophrenics.

Table showing Results of Individual Chess Match Games in Relation to Type of Mental Disorder and Chronicity.

Initials.	Age.	Date of admission.	Date of discharge.	Diagnosis.	Position in team.	Matches.			
						Played.	Won.	Drawn.	Lost.
S. A— (captain)	56	1936	..	Recurrent mania	1-3	10	6	0	4
J. V. G. B—	47	1933	..	Schizophrenia	1-4	10	4	2	4
H. B. B—	66	1920	..	"	2-5	10	6	0	4
R. L. M—	68	1909	..	"	2-5	10	5	2	3
W. H. L—	41	1937	..	"	3-6	10	4	0	6
E. E. M—	60	11.ii.47	7.iii.48	Manic-depressive	6-7	7	2	0	5
C. T—	47	1942	..	Schizophrenia	7-12	5	2	1	2
W. C—	19	16.xi.45	3.vii.48	"	7-10	7	2	0	5
W. A—	53	1929	..	High grade defective	6-15	7	2	0	5

Although the object of this article is mainly to stimulate similar activity in other mental hospitals and to bring chess into line with cricket and football, so that inter-hospital matches could be arranged, I would like to put forward the suggestion that chess, from the psychiatric point of view, is not merely another form of recreation therapy, but that it is an intelligence test of which much use could be made. Supposing, for instance, a player were to play a series of recorded games both before and after a leucotomy, it might be possible to detect changes, not only in the intelligence, but in the personality, e.g. the cautious player might become reckless, or the man who plays a good attacking game might change to a defensive policy. It would be also interesting to know whether Golla (1943) is correct in supposing that a leucotomized chess player "would be able to see moves ahead as before." I am already convinced, however, that an attack of insanity does not necessarily interfere with the competence of a good chess player.

I wish to thank Dr. J. D. Silverston, Medical Superintendent of the hospital, for permission to publish this article.

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Part II.—Reviews.

Modern Trends in Psychological Medicine. Edited by NOEL G. HARRIS, M.D., F.R.C.P., D.P.M. London: Butterworth and Co. Ltd., 1948. Pp. 450. Price 50s. net.

This work is not just another systematic presentation of psychiatry, formal and stereotyped, but it is an attempt to capture the imagination of all thoughtful medical persons whether they are or are not psychiatrists. An attempt is made—and in most instances it is a successful attempt—to state and evaluate the place of psychiatry, both in relation to the individual and to national and even international affairs. To effect his purpose Dr. Harris has enlisted the help of a galaxy of talent, a British-American team, which includes among others Samson Wright (Professor of Physiology, London University), H. R. Hamlay (Professor of Education, London University), and J. H. Masserman (Assistant Professor of Psychiatry, Chicago). All of the contributors, however, are persons whose judgment and experience can be relied on. As in all books of this type there is a considerable overlap but there is no serious divergence of opinion. The standard set throughout is high, and while some of the articles will appeal more to some people than to others, yet the whole book is stimulating, instructive, and valuable for every practising psychiatrist.

The opening chapters by Harris, dealing with the Psycho-somatic concept and the importance of the Constitutional Factor, give a clear, well-balanced account of modern trends. Then follows Samson Wright's study of the Physiology of Emotions in which he describes in detail animal experimentation, and also discusses the cortico-thalamic interconnection in the light of the now familiar operation of leucotomy. He summarizes the physiological situation by stating that we cannot as yet go much further than the knowledge which Sherrington gave us in his "Integrative Action of the Nervous System."

McInnes, in his consideration of Causative Factors, deals with the topic in terms of reaction types rather than in relation to specific factors. No one cause is ever entirely specific but must always be considered in relation to the constitutional background and environmental factors. He has been impressed by the physiological approach of Sherrington, Symonds and Masserman, but in the end he comes down in favour of a broad-minded interpretation in terms of "a knowledge of personal philosophy." Perhaps he is not so critical as he might be in relation to the etiological significance of the endocrine, biochemical and vitamin factors. Again, however, one finds an interpretative, etiological outlook which calls for thought and consideration.

Golla deals with electro-physiology and finds progress in electro-encephalography so rapid that it is almost impossible to give an accurate appraisalment of what it is accomplishing to-day. He is inclined to speculate in relation to what we may expect in the future. He is in favour, during history-taking, of connecting the patient with an electrical apparatus so that the tension and emotional reaction of the patient may be recorded. He believes that every mental hospital or clinic should be equipped with such an apparatus. Such advice is very questionable. Many patients, nervously and mentally ill, are so suspicious, restless, perturbed, and ill-at-ease during the ordinary interview that it is probable that their emotional reactions would be greatly heightened and disturbed by a recording apparatus. There is a grave danger that clinical acumen and observation will soon become entirely discounted if too great reliance is placed on scientific aids.

Martin James, in dealing with Diagnostic Measures, is rather unconvincing

He favours a much more intense subjective approach, and apparently approves of the psychoanalytic training both of psychologists and psychiatrists. It is still very problematical whether lay analysts should be allowed to practice medicine.

The chapters by Griffiths on Marriage and Family Life, by Moodie on Child Guidance, and by Whitehorn on Psychotherapy are well written and informative. Stalker's discussion of the Psychopathic Personality is almost the most specific clinical problem dealt with. He has done it in a comprehensive and satisfying manner, and emphasizes that the concept immaturity which forms so much of the psychopathic state does not mean an inability to mature but rather the potentiality to do so provided the proper help is at hand. The introduction of the Criminal Justice Bill, and the development of criminological science should help to amalgamate the medical and legal viewpoint. That would indeed constitute a forward step in helping a group of people who are in desperate need of assistance.

After a series of articles—very competent articles—dealing with Mental Hygiene, Character Formation in relation to Education, Physical Methods of Treatment, Social and Group Psychotherapy, Personnel selection, Mental Hygiene in Industry, and Rehabilitation, the book, appropriately enough, is brought to a close by a chapter on Psychological Medicine and World Affairs, by Jules H. Masserman. This is most ably done. Criticism is at once stifled by Masserman's apologium. He states at once that he fully recognizes the limitation of psychiatry—and of psychiatrists, but he believes that the study of individual motivations is some excuse for the psychiatrist to enter the field of World Affairs. The note struck, however, is not a particularly encouraging one. He believes that there is reason to suppose that the incidence of psychiatric disorders will rise even more rapidly in our present era of dubious "peace" than it did in war-time. Now, we do not have the stabilizing effect of urgent purpose and the relief of concerted group action. "The entire world seems to be drifting into strangely familiar but now ominously pervasive forms of social psycho-pathology—and with no refuge in sight."

His principle hope for the future seems to be our ability to organize internationally so as to combat want and fear. He urges psychiatrists to secure some influence on policy-making and governing bodies because our experience with "anxiety ridden men" should enable us to understand the motivations, fears and patterns of action of those who may be the leaders of the nation. That is a laudable hope, it is one which every one would like to see made possible, but it will require many years before leaders are ever likely to co-operate with or be influenced by such a plan.

This book is one well worthy of intensive study, it is most thought-provoking and valuable. The editor should be warmly congratulated on having done a very efficient piece of work. In a future edition a chapter by a Psychiatric Social Worker might be included.

D. K. HENDERSON.

The Adolescent Child. By W. D. WALL. London: Methuen & Co., 1948. Pp. x + 206. Price 8s. 6d.

This book attempts to describe the psychological characteristics of adolescents. Information is derived from other works and the author's investigations by means of questionnaires and tests. It suffers severely from clinical weakness, e.g. folie à deux and neurasthenia are wrongly described and Stengel's work on fugue states has made the postulation of a migratory impulse unnecessary. Adequate medical help would have eliminated such mistakes and made the book more readable. As it is, it contains numerous statements about emotional development without the theory that could co-ordinate them and give them meaning, and the work tends to be as dull as a dictionary—but not as accurate.

It is difficult to see for whom it is intended. It is too long and detailed for the parent and too elementary for the student. Perhaps there is room for a book on this subject provided the author shows a sound knowledge of psychopathology, for the difference between the normal and the abnormal is mostly merely a matter of degree.

E. S. STERN.

Occupational and Physiotherapy. By R. H. FINNEGAN. London: The Actinic Press, 1948. Pp. 127. Price 6s.

This little book is an introduction explaining the nature and scope of the work. There are chapters on history, training, qualifications, special fields, methods, equipment, departmental management, prospects, salaries, etc., covering each type of therapy. The writing is clear and the advice given is sound. There are, however, a few small inaccuracies which should be corrected in the next edition: most girls come from primary schools and so do not hold school certificate, nor is athletic skill highly correlated with craft ability (p. 16), artistry and proficiency in design are as necessary to the occupation therapist as the other qualities mentioned (p. 18), the address of St. Andrew's Hospital is wrongly given in one place (p. 22), and McDougall is misspelt (p. 28). The statement that diabetes is often completely cured if attended to in time is unfortunately untrue.

But these are minor faults, and the book is recommended to those contemplating a career in occupational or physiotherapy.

E. S. STERN.

Inside the Asylum. By JOHN VINCENT. London: George Allen & Unwin, 1948. Pp. 115. Price 6s.

Too many books are being published in which the author describes his own mental illness as if it was unique and of value to the world, not realizing that such experiences are only too commonplace. In this case, however, unusual insight is shown and the psychosis is related to some of the causative events in an unhappy childhood. At the onset of symptoms he suffered unnecessarily long owing to the failure of his doctors. Such tragedies show how urgent is the need for better psychiatric education of the general practitioner. Some of his criticisms of mental hospitals are ill informed, but others, such as not being told what clothes to bring, being left hungry on admission, lack of privacy and quiet, and clumsy shaving, are genuine enough. He is grateful for the excellent psychotherapy he received. It is a pity that such a well told tale is marred by a sensational dust cover design by G. N. Finch, and an intemperate introduction by Vera Brittain.

E. S. STERN.

Psychiatry. By WILLIAM C. MENNINGER, M.D. Ithaca, New York: Cornell University Press, 1948. Pp. xi + 138. Price 2\$.

These are the Messenger Lectures for 1947 delivered at Cornell University. Dr. Menninger gives a scholarly, learned, and readable review of psychiatric history, psychopathology, and social psychiatry. His language is clear and effortless, and even those who are ignorant of the subject will benefit from and be interested by this volume. Indeed it is hard to conceive of the work being better done. The paper, printing and production are excellent, making a tasteful and desirable book.

E. S. STERN.

A Modern Introduction to Psychology. By REX KNIGHT, B.A., and MARGARET KNIGHT, B.A. Published by University Tutorial Press, Ltd. Price 7s. 6d.

In a small book which sets out to introduce the university student into psychology, one cannot expect an adequate treatment of all aspects of this vast subject. Everything essential should be presented in a clear language

without too many technical terms and yet not cheaply popularized. The space allotted to each topic should be carefully balanced. Large parts of the book come close to this ideal as, for instance, the chapters on learning, memory, instincts, attention and others. Equally satisfactory is an outline of Freud's theory under the headings: Conflict, Anxiety and Guilt, the Subconscious and Dreams. The names of Jung and Adler should be mentioned when their views are discussed. Unfortunately, psychologists insist that anatomy and physiology of the nervous and the endocrine systems should be included in an introduction like this. Their presentation is so superficial that it cannot serve any useful purpose. These chapters should be omitted and the student referred to special books on this subject. Instead of paragraphs on prefrontal leucotomy and E.C.T., one would like to see a chapter on the psychology of personality and something more on heredity and environment and on the use and limitations of statistical methods in psychology.

The book is well laid out: the diagrams and examples illustrating various points in the text are well chosen. Particularly valuable are the "Notes on Reading" at the end of each chapter.

A. D. WEATHERHEAD.

Part III.—Bibliography and Epitome.*

AN attempt is being made to provide as far as possible a complete bibliography compiled from journals dealing with Psychiatry and Neurology (which are really inseparable) and their ancillary subjects, psychology, anatomy of the nervous system, criminology, etc.

If any reader can add the names of journals to the following list, which it is hoped to publish each year in the January number, the addition will be gratefully received and acknowledged.

Those journals which are available in the Library of the Royal Medico-Psychological Association are marked "1," those available in the Library of the Royal Society of Medicine are marked "2," those in the Library of the British Psychological Society are marked "3," and those in the Library of the British Medical Association are marked "4."

The titles of these journals are mostly in the form given by the Board of Editors of Publications of the American Psychological Association, January, 1939. Contributors are requested to use the exact form given below.

PSYCHIATRIC JOURNALS.

- 2 *Abh. Neur. Psychiat.*
Abh. Psychother.
- 2 *Acta Española Neur. y Psiquiat.*
Acta Neurol., Naples.
- 2, 4 *Acta Neurol. Psychiat. Belg.*
- 2, 3, 4 *Acta Psychiat. et Neurol., Copenhagen.*
- 3 *Acta Psychol., Hague.*
Acta Psychol., Keijo.
Alcohol Hyg.
Alg. Neder. Tijdschr. Wijsbegeert. Psychol.
Aliéniste Français.
- 2 *Allg. Ztschr. f. Psychiat.*
Altersprobleme.
Amer. Imago.
- 2 *Amer. J. Ment. Def.*
- 2, 3 *Amer. J. Orthopsychiat.*
- 1, 2, 3, 4 *Amer. J. Psychiat.*
Amer. J. Psychoanal.
- 2, 3 *Amer. J. Psychol.*
Amer. J. Psychotherap.
Amer. Psychologist.
An. Bras. Hig. Ment.
An. Istit. Psicol. Univ. B. Aires.
An. Psicotec., Rosario.
Anal. Inst. Neurol., Montevideo.
Analele Psihol. (Rumania).
Anales de psicol., Buenos A.
- 2, 3 *Année Psychol., Paris.*
- 2, 3 *Ann. Méd.-Psychol., Paris.*
- 2 *Ann. Osp. psichiattr., Perugia.*

* A number of extracts in this section are reproduced from *Chemical Abstracts* and *Psychological Abstracts*. To the Editors of these two Journals we extend our grateful thanks.

- Appl. Psychol. Monogr., Washington.*
Arb. Psychiat. Inst., Sendai.
Arch. Anthropol. crim.
 2 *Arch. Argent. de Neurol.*
Arch. Argent. Psicol. norm. pat.
 2 *Arch. Bras. de Neur. e Psiquiat.*
Arch. Brasil Hig. Ment.
Arch. Chilenos de Crim.
Arch. Ital. di Studi Neuropsich.
 1, 2 *Arch. Neurobiol.*
Arch. Neurocir., Paraguay.
 4 *Arch. Neurol., Paris.*
 2 *Arch. de Neurol. de Bucarest.*
 1 *Arch. de Neurol.*
 2 *Arch. di Antropol. Crim.*
Arch. di Crim. Neuropsiquiat. y Disc. Con., Quito.
Arch. di Sci. Cereb. Psich., Salerno.
 2, 4 *Arch. f. Psychiat.*
 2, 3 *Arch. ges. Psychol.*
Arch. Internat. de Neurol.
Arch. Ital. Psicol.
Arch. Krim. Anthropol.
 1, 2, 3, 4 *Arch. Neurol. Psychiat., Chicago.*
Arch. Neur. Psychiat., Mex.
 2, 3 *Arch. Psicol., Neurol., Psichiat. e. Psicoter., Milan.*
 2, 3 *Arch. Psychol., Genève.*
 2, 3 *Arch. Psychol., N.Y. (ceased publication 1945).*
Arch. Relig. psychol.
Arch. Speech.
Arq. da Assist. a Psicop. de Pernambuco.
Arq. de Neuro-psiquiat., Brasil.
 3 *Aust. J. Psychol. Phil., Sydney.*
- Behaviour.*
Beih. Schweiz. Z. Psychol. Anwend.
Beih. Zbl. Psychother.
Bol. Inst. Psiquiat., Rosario.
Bol. Inst. psicopedag., Lima.
 2, 3, 4 *Brain.*
 3 *Brit. J. Educ. Psychol.*
 2, 4 *Brit. J. Inebriety (now Brit. J. Addiction).*
 1, 2, 3, 4 *Brit. J. Med. Psychol.*
 2, 3, 4 *Brit. J. Psychol.*
 2, 3 *Brit. J. Psychol. Monogr. Suppl.*
Bull. Canad. Psychol. Ass.
 2, 4 *Bull. de la Soc. de Psychiat. de Bucarest.*
 2 *Bull. de la Soc. Roumaine Neur. Psychiat. Psychol. Endocrin.*
Bull. du Group. Franç. d'étud. de neuro-psychopath. infant.
 2 *Bull. industr. Psychol., Melbourne.*
 2 *Bull. Los Angeles Neurol. Soc.*
 2 *Bull. Menninger Clin.*
Bull. Milit. Clin. Psychol.
Bull. Soc. Psihol. med., Sibiu.
- Canad. Journ. Occup. Ther.*
Canad. J. Psychol., Toronto.
 2 *Cervello.*
 2, 3 *Character and Per. (now J. Personality).*
 2 *Child Developm.*
 2 *Child Developm. Abstr.*
Child Developm. Monogr.
Child Study.

- Chin. J. Educ. Psychol.*, Chungking.
Chin. J. Psychol.
 3 *Comp. Psychol. Monogr.*
 2 *Confinia Neurol.*
Contr. del Lab. di Psichol.
Contr. Lab. Psicol., Milan.
Contr. psychol. Theor.
Criança Portuguesa.
Criminalia, Mexico.
- 2 *Deutsche Ztschr. f. Nervenh.*
Dig. Neurol. Psychiat.
 2 *Dis. Nerv. Syst.*
- 3 *Educ. psychol. Measmt.*, Washington.
Egypt. J. Psychol., Cairo.
Electroenceph. Clin. Neurophys., Boston.
- 1, 2, 3, 4 *L'Encéphale.*
 2 *Epilepsia.*
Evolut. Psychiat.
- Fiziol. Th. S.S.S.R.*
 2 *Folia Neuropath. Esthon.*
 2 *Folia Psychiat. et Neurol. Jap.*
 2 *Fortsch. Neur. Psychiat.*
- 3 *Genet. Psychol. Monogr.*
Geriat., Minneapolis.
Giorn. di Psich. e di Neuropat.
- Hum. Factor.*
Hum. Relat., Cambridge, Mass.
- 2, 3, 4 *Hyg. Ment.*
- Illinois Psychiat. J.*
 2 *Index Neurol. y Psiquiat.*, Buenos Aires.
 3 *Indian J. Psychol.*, Calcutta.
Indiv. Psychol. Bull., Chicago
 3 *Industr. Psychol.*
 3 *Industr. Psychotech.*
 1, 2, 3, 4 *Int. J. Psychoanal.*, London.
 2, 3 *Int. Z. Psychoanal. u. Imago.*
- Jap. J. appl. Psychol.*
Jap. J. Exp. Psychol.
Jap. J. Psychol.
- 1, 2, 3 *J. Abnorm. Soc. Psychol.*, Washington.
J. Amer. Soc. Psychic. Res.
 3 *J. App. Psychol.*, Washington.
 2, 4 *J. Belge Neur. Psychiat* (now *Acta Neurol. Psychiat. Belgica*).
J. Child. Psychiat.
J. Clin. Psychol., Burlington.
 2 *J. Clin. Psychopath.*, Montecello, N.Y.
 2 *J. Comp. Neur.*
- 1, 2, 3 *J. Comp. Physiol. Psychol.*, Washington.
J. Consult. Psychol., Washington.
J. Crim. Law and Criminol., Chicago.
 2 *J. Crim. Psychopathol.* [now *J. Clin. Psychopath.*].
 2 *J. de Psychiat. Infant* [now *Zeit. f. Kinderpsychiatrie*].
 3 *J. Educ. Psychol.*, Baltimore.
J. Except. Child.
- 3, 4 *J. Exp. Psychol.*, Washington.

- 2 *J. f. Psychol. u. Neurol.*
- 3 *J. Gen. Psychol.*, Provincetown, Mass.
- 2, 3 *J. Genet. Psychol.*, Provincetown, Mass.
- 2 *J. Geront.*, St. Louis.
- J. Juvenile Res.*
- 1, 2, 3, 4 *J. Ment. Sci.*, London.
- 1, 2, 3 *J. Nerv. Ment. Dis.*, New York.
- 1, 2, 3, 4 *J. Neurol. Neurosurg. Psychiat.*, London.
- J. Neuropath. and Psychiat.*, Leningrad.
- 1, 2 *J. Neuropath. Ex. Path.*
- 2, 4 *J. Neuropsychiat.*
- J. Neuropsychiat. du Pacifique.*
- 2 *J. Neurosurg.*
- 3 *J. Parapsychol.*, Durham, D.C.
- 2 *J. Personality*, Durham, D.C.
- J. of Psychic. Res.*
- J. Psihoteh.*
- 2 *J. Psycho-Asthen.* [now *Amer. J. Ment. Deficiency*].
- 1, 2, 3 *J. Psychol.*
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- 2, 3 *J. Psychol. Neurol.*, Leipzig.
- 2 *J. Psychol. Norm. Path.*, Paris.
- J. Soc. for Psychic. Res.*
- 3 *J. Soc. Psychol.*, Provincetown, Mass.
- 2 *J. Speech Dis.*, Danville, Ill.

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- 3 *Kwart. Psychol.*

Mag. psychol. Szle.

- Menn. Miljö.*
- 2 *Ment. Health*, London.
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- Ment. Hyg. Rev.*
- Ment. Hyg. Bull.*, Indiana.
- 3 *Mind*, London.
- Monats. Psychiat. Neurol.*
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- 2 *Neopsychiat.*
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- Nerv Child*, New York.
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Obshch. Klin. Nevropat.

- 2, 3 *Occup. Psychol.*, London.
- 2 *Occup. Ther. and Rehabil.*
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Pisani.

Polsk. Arch. Psychol.

Prace Psychol.

2 *Proc. Amer. Assoc. Stud. Ment. Def.* [now *Amer. J. Ment. Deficiency*].

2 *Proc. A. Res. Nerv. and Ment. Dis.*

3 *Proc. Soc. Psych. Res., London.*

Prog. Neurol., Psychiat.

3 *Psichotec.*

Psicoanalisi, Rome.

Psicoter., Cordoba.

Psyche, Cambs., Mass.

Psychiat. Monogr.

2 *Psychiat. en Neurol. Bl., Utrecht.*

2 *Psychiat. et Neurol. Jap.*

2 *Psychiat. Neurol. Wchnschr.*

2 *Psychiat., Washington.*

1, 2 *Psychiat. Quart., Utica, N.Y.*

2, 3 *Psychoanal. Quart., Albany, N.Y.*

2, 3 *Psychoanal Rev., New York.*

Psychodrama Monogr.

1, 2, 3 *Psychol. Abstr., Washington.*

1, 2, 3 *Psychol. Bull., Washington.*

Psychol. Clin.

Psychol. Exch.

3 *Psychol. Forsch.*

Psychol. Index.

2 *Psychol. Monogr., Washington.*

Psychol. Rec.

3, 4 *Psychol. Rev., Washington.*

3 *Psychol. Rev. Monogr.*

Psychol. Sbornik.

Psychol. Stud. Kbh.

Psychol. Stud. Univ. Bp.

Psychol. wychow.

3 *Psychomet., Chicago.*

Psychometr. Monogr.

2 *Psychosom. Med., New York.*

2 *Psychosom. Med. Monogr., New York.*

Psychotechnick.

Quart. J. Child. Behav., New York.

Quart. J. Speech.

2 *Quart. J. Stud. Alc., New Haven, Conn.*

2 *Quart. Rev. Psychiat. Neur., Washington.*

Rass. Neurol. Veget., Firenze.

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Rev. Argent. Neurol. Psiquiat.

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Rev. di Psiquiat. y Crim.

Rev. Espan. de Oto-neuro-oftal. y Neurocir.

3 *Rev. Franç. Psychoanal.*

Rev. Ibero-Amer. de Anal. Biblio. de Neurol. y Psiquiat.

Rev. Mex. Neurol. Psiquiat. y Med. Legal., Mexico.

1, 2, 4 *Rev. Neurol.*

2 *Rev. Neurol. de Buenos-Aires.*

Rev. Neurol. Psychiat., Praha.

2 *Rev. Neuro-Psiquiatr., Lima.*

2 *Rev. Oto-Neur.-Oftal. Cir. Neur. Sud-Am.*

- Rev. Neuropsychiatr.*
Rev. Psicol. Gen. Aplic., Madrid.
Rev. Psicol. Pädag.
Rev. Psicoanal., B. Aires.
 3 *Rev. Psihol.*
Rev. Psihol. Icor. Aplic., Sibiu.
 2 *Rev. Psiquiat. Crim., B. Aires.*
Rev. Psiquiat., Uruguay.
Rev. Psiquiat. y Disc. Con., Chile.
Rev. Psychol., Montreal.
Rev. Sudam. Psicol. Pedag.
Rev. Tchèque de Neurol. et de Psychiat.
Ric. Psych.
 2, 3, 4 *Riv. di Neurol.*
Riv. di Neuro-psiquiat., Peru.
 3 *Riv. di Psychol.*
Riv. Ital. di Endocrin. e Neurochir.
 2 *Riv. Patol. nerv. ment.*
Riv. Psychol. Norm. Pat., Ferrara.
 2, 4 *Riv. Sper. Freniat.*
 1 *Rocz. Psychjat.*
 2 *Rorschach Res. Exch. J. Prog. Techn., New York.*
Samikšā.
 1 *Schizofrenie.*
 2 *Schweiz. Arch. Neurol. Psychiat.*
Schweiz. Z. Psychol.
Schweiz. Z. Psychol. Anwend., Bern.
Skand. Arch. Psychol.
Sovet. nervropatol., psichiatri, psichoguogua.
Sovet. Psychoneurol.
Sovet. Psikhotekh.
Speech Monogr.
 2, 3 *Stud. Psychol. Psychiat. Cathol. Univ. Amer.*
Tidskr. Psykol. Pedag.
Tohoku Psychol. Folia.
 2 *Tr. Am. Neurol. A.*
Tr. Beritov Inst., Tiflis.
Tr. Kostchenko Ment. Hosp., Moscow.
 2 *Trud. fiziol. Lab. Pavlova.*
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Univ. Calif. Publ. Psychol.
Univ. Iowa Stud. Psychol.
Untersuch. Psychol. Phil.
Wien Z. Phil. Psychol. Pädag.
 3 *Z. angew. Psychol.*
Z. Arb. Psychol.
Z. Berufs. des Pflegepers.
Z. Individ. Psychol.
 2, 4 *Z. ges. Neurol. Psychiat.*
 2 *Z. Kinderpsychiat., Basle.*
 3 *Z. Pädag. Psychol.*
Z. Parapsychol.
 2 *Z. Psych. Hyg.*
Z. Psychiat. Neurol. Klin. Psychol.
Z. Psychoanalyse, Tokyo.
 3 *Z. psychoanal. pädag.*
 2, 3 *Z. Psychol.*

- Z. Psychother. med. Psychol.*
Z. Tierspsychol.
 2 *Zbl. Neurochir.*
 1, 2 *Zbl. ges. Neurol. Psychiat.*
Zbl. Psychotherap.

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The Pathology of Gargoylism.

A case of gargoylism in a 3-year-old girl, with gross and microscopic post-mortem examination, provided an opportunity for comparing the reported findings with those in the present example.

The previously described lesions in the central nervous system, eyes, skeleton, and visceral organs are for the most part confirmed. Emphasis is placed on striking alterations in the connective tissues of the viscera, cardiovascular system, and skeleton, which hitherto had not been observed. These are characterized by the presence of large vacuolated cells, probably fibroblasts for the most part, in association with a proliferation of collagenous fibres and sometimes with an increase of ground substance.

These alterations have a role in producing some of the characteristic clinical manifestations of gargoylism (hydrocephalus, skeletal deformities, cardiac symptoms).

The nature of gargoylism must be considered in its relation to the known diseases of lipid metabolism (amaurotic idiocy, Niemann-Pick's disease, Gaucher's disease). The inclusion of gargoylism in the group of storage diseases is suggested because of the evidence of storage in many cells of the body, and because of the similarity of the changes in the central nervous system with those in amaurotic idiocy; but the chemical nature of the stored substance thus far has not been identified. It appears that there is a widespread disturbance of intracellular metabolism resulting in the accumulation of an abnormal substance in many cells of the body. However, the question whether gargoylism is a form of lipidosis must remain open.

(Author's abstr.)

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Psychopharmacologic Study of Schizophrenia and Depression. IV. The Influence of Electric Convulsive Therapy on the Sodium Amytal Response of the Electroencephalogram.

1. Nine patients, 4 with depression, 5 with schizophrenia, were studied with respect to changes in the beta activity of the EEG induced by the intravenous injection of sodium amytal mg. 250 (with racemic amphetamine sulfate mg. 20). These changes were measured on five consecutive days prior to a course of electric convulsive therapy. They were again studied in a single session, after this course of treatment.

2. There was observed to be a striking increase in beta activity after the injection. This increase was greatest in the frontal EEG, least in the occipital EEG, forming an anterior-posterior per cent. time gradient, which was an accentuation of the pre-injection gradient.

3. There was no systematic electrocortical tolerance developed in either group to the drug over a 5-day period. The schizophrenic group, however, developed the usual psychological tolerance.

4. After a course of electric convulsive therapy there was a decrease in per cent. time beta; the response of beta to sodium amytal was greatly reduced, particularly in the frontal area.

5. These data suggest that the electro-cortical response measured (per cent. time beta) and the psychologic state are reflections of the activity of different neural systems.

(Authors' abstr.)

Cerebrospinal Fluid Changes in Electroshock Treatment of Psychoses. (Spectrophotometric and Enzyme Studies.)

1. The cerebrospinal fluid of untreated schizophrenics shows a pronounced selective absorption in ultraviolet at $\lambda = 2650 \text{ \AA}$.

2. Electroshock treatment influences the ultraviolet absorption of the cerebrospinal fluid (initial decrease, followed by increase on repeated application of high A.C.).

3. Enzymatic substances apparently belonging to the groups of nucleases and desaminases increase in the C.S.F. following electroshock convulsions.

4. Lipases are much less affected by electroshock convulsions than are the nucleases.

(Authors' abstr.)

The Effect of Electric Shock on Mental Efficiency.

The present study has attempted to determine the effect of electric shock treatment on mental efficiency. The population studied included 75 patients, suffering from depression, hypomania, or psychoneurosis. The mean age was 41.2 years; the mean number of shocks was 7.8. On Babcock tests administered an average of 11 days after shock there was a slight but not significant improvement. On the Shipley test the improvement was probably significant. When the same tests were administered after a follow-up interval averaging 189 days, there was relatively great and statistically significant improvement on both tests. Babcock scores obtained by the patient group about 6 months after shock were not significantly lower than the scores of a normal population of 17 persons of the same age and vocabulary level. It may be concluded that, for the population studied and under the conditions of the present experiment, electric shock treatment does not produce any significant impairment of mental efficiency after an interval of six months. No correlations were found between age and improvement from test period to test period. There was some evidence that patients receiving a greater number of shocks were affected more in mental efficiency than those receiving a lesser number of shocks.

(Authors' abstr.)

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Cerebral Blood Flow and Metabolism in Schizophrenia. The Effects of Barbiturate Semi-Narcosis, Insulin Coma and Electroshock.

Studies by the use of the nitrous oxide technique on 22 schizophrenic patients show no deviation from values obtained in normal young males for cerebral blood flow and oxygen consumption.

A clinically significant change in 8 patients given sodium pentothal or amytal intravenously is not associated with a measurable change in cerebral blood flow or cerebral oxygen consumption.

Insulin hypoglycemia and coma is associated with a progressive decrease in cerebral utilization of oxygen and blood glucose, the cerebral circulation remaining unimpaired. The fall in blood glucose utilization is greater than that of oxygen.

Electroshock is followed by a moderate decrease in metabolism and a marked decrease in cerebral blood flow in the face of a severe acidosis.

Although there were no demonstrable deviations from the normal in this group of schizophrenic patients, the authors' experience with this technique leads them to believe that it is worthy of extensive application in the study of the metabolic derangements in the brain associated with mental disease. It makes possible a new approach to psychiatric disorders, and gives the means of quantitatively determining the utilization or production of any substance capable of accurate analysis in the arterial and internal jugular venous blood. (Authors' abstr.)

Cerebrospinal Fluid Studies in Advanced Dementia Praecox.

After 13 months of intensive investigation of 40 very deteriorated dementia praecox patients, the writers are unable to confirm the conclusions of numerous European and some American authors concerning the postulated etiological relation between M. tuberculosis and dementia praecox. (Authors' abstr.)

The Prediction of Huntington's Chorea. An Electroencephalographic and Genetic Study.

Twenty-six offspring representative of 9 families with Huntington's chorea in the immediate ancestry were subjected to the following studies: Physical, neurological, psychiatric, psychometric, anthropometric, genetic, and electroencephalographic. Of these various procedures but two seemed to offer probable predictive value: namely, the EEG and the blood groupings. Nineteen (73.1 per cent.) of the subjects showed definite electroencephalographic abnormalities, particularly in the motor regions. Bilateral paroxysmal bursts like those observed in epilepsy were found in the resting record of about half (8) of the cases showing abnormal EEGs. According to a composite weight, 12 offspring had the highest electroencephalographic abnormality, and were thought likely to develop the disease as this proportion approximated the genetic probability. No definite intra- or inter-family, or parent-offspring, electroencephalographic resemblances were noted. The study of blood groupings was expanded to include all available cases of Huntington's chorea in addition to the offspring study, and disclosed a disproportionately large number of individuals in Groups A and O. Long-range follow-ups with repeated EEGs on a larger series of offspring are recommended as well as a much more extensive examination of the blood groupings of Huntington's chorea patients and their offspring in order to establish the statistical validity of the two procedures. (Authors' abstr.)

The Hospital Treatment of Involutional Psychoses.

In the group of 100 patients who did not have electric shock treatment, 42 per cent. were distinctly benefited after a follow-up period of from 7-16 years. Thirty-two were recovered; 10 were much improved. Twelve had died; 9 were unimproved; 4 were suicides. The average period of hospitalization for those distinctly benefited was over two years.

The results in a group of 69 additional patients with similar histories, personalities, and psychoses who received electric shock therapy besides the usual psychiatric treatment were much better. At the end of a follow-up period of 1-5 years after leaving the hospital, 33 were recovered, 16 much improved. These 49 patients representing almost 75 per cent. of the group were home and functioning in the community. Less than 20 per cent. were unimproved, and of these 3 were suicides. There were no other deaths. The average length of hospitalization was only 8 months for the shock-treated group, in contrast to the 2-year period in the group who did not have electric shock.

Most shock-treated patients had more than one series of electric shock treatment. One patient recovered after five series spaced at monthly intervals. Shock treatment broke into the rut of symptoms and permitted the development of a close personal relationship with these patients. Advantage was taken of this contact to give intensive psychotherapy, and this was believed to be instrumental in their eventual recovery. In spite of the relatively advanced age of these patients and the rigidity of their prepsychotic personality, most who recovered after electric shock treatment displayed a distinct capacity for modification of their previous personality traits, which resulted in a better adjustment to life than that before their mental illness.

(Authors' abstr.)

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Evaluation of Leucotomy Results.

Investigations of discharged cases after successful leucotomy resulted in the following findings:

1. The likelihood of a patient being discharged after leucotomy is greater if he is less than middle-aged; it does not depend on the preoperative duration of illness if the personality is preserved.

2. Discharge is also significantly higher when leucotomy is performed as a low vertical incision.

3. It is demonstrated that personality modifications can be better achieved by the orbital than by the other types of operative incisions. These personality changes are attributable to structural damage of the lower quadrants of the frontal lobes.

4. These postoperative personality changes are superimposed on the pre-existing symptomatology, and it was found that patients showing introversion, lack of initiative, shallowness of affects, etc., are more likely to respond favourably to the low vertical cut.

5. The reintegration between the pre- and postoperative symptomatology is a function of the total personality. Deteriorated patients are incapable of readjustment, and only cases with well-preserved personalities should be operated upon.
(Author's abstr.)

Presenile Psychosis : Report of Two Cases with Brain Biopsy Studies.

Two cases of Pick's disease are presented in which brain biopsy studies were made. The clinical, differential diagnostic, and neuropathological aspects of these cases are discussed.

This long neglected and poorly understood clinical entity—the presenile psychosis—is now receiving the close attention and careful scrutiny of more progressive neuropathologists and biochemists. The emphasis is no longer on changes in morphology, but rather on the alterations occurring in the metabolism of brain tissue. With newer methods and finer techniques we can look forward to a better understanding of previously obscure neuropsychiatric disorders.

(Authors' abstr.)

Early Senile Dementia in Mongoloid Idiocy:

In 3 mongoloid patients, aged respectively 47, 42 and 37 years, personality changes and mental deterioration were observed. Pathologically, evidence of senile changes was obtained consisting of degeneration of neurons, numerous senile plaques, and Alzheimer's neurofibrillary changes.

With the exception of the age of onset, the clinical and pathological manifestations are those of senile dementia.

Since mongoloid patients show a marked tendency to develop this type of reaction, it is suggested that the study of it offers some information which may contribute to a better understanding of the causes of senile dementia.

(Author's abstr.)

Psychiatric Observations on Induced Vitamin B Complex Deficiency in Psychotic Patients.

These studies indicate that vitamin B complex restriction caused severe primary mental changes or aggravation of pre-existing psychotic trends among the psychotic subjects.

The character of the mental changes appeared to depend on speed and severity of the deprivation.

Patients whose B complex intake was so restricted that it contained 400 mcg. of thiamine and correspondingly small intake of other B complex factors showed diminution of psychomotor activity, dulling of affect, loss of interests and ambitions.

In some of the severely depleted patients whose thiamine intake was restricted to 200 mcg. daily, serious emotional disturbances with loss of inhibitory control developed. In others, pre-existing affective trends such as hypomanic and mildly depressive features became markedly exaggerated. The formation of paranoid trends also was observed.

Among the group moderately deprived of vitamin B complex the mental changes developed slowly in the course of three years. However, among the subjects severely deprived of vitamin B complex, mental disturbances manifested themselves explosively, acutely, or subacutely, after only a few months of depletion.

(Authors' abstr.)

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Organic Mental Syndrome with Phenomena of Extinction and Allesthesia.

In a patient with severe mental deterioration, routine neurological examination disclosed minimal signs of a focal lesion in the brain. Special methods, however, such as bilateral simultaneous stimulations, revealed that the patient perceived best on the left side. Although she felt a stimulus applied to her right side, this percept became extinct as soon as another stimulus was applied to the left side of

her body (extinction phenomenon). In these circumstances she perceived only the one on the left side. The extinction phenomenon was found to be present when her cutaneous, kinesthetic, visual or auditory perceptions were thus tested. The patient also showed the phenomenon of allesthesia. Not infrequently she localized an object she saw, heard or felt to the left side, even though the stimulus object was applied to the right side of her midline.

Related to the sensory dominance of the left over the right side was the patient's preferred use of the extremities on the left side and her preference to turn toward her left side. Akin to the allesthesia was the finding of a disorientation in her cutaneous visual or auditory space on the right side of her body.

Besides the perceptual and motor disorders, the patient showed pronounced intellectual changes. Most conspicuous was the patient's inability to perform a task unless there was unity of idea or action. If there was more than one salient aspect in a situation, she failed in her task.

Theoretic explanations for the phenomena of extinction, allesthesia and spatial disorientation are offered, and the relation between the systematic perceptual-motor disorders and the systematic intellectual changes is discussed. These alterations in function can be best understood when considered in terms of collective action within the nervous system as a whole. (Authors' abstr.)

Causes of Failure in Treatment with Electric Shock : Analysis of Thirty-Eight Cases.

This report concerns 38 of a series of 200 patients who failed to respond favorably to shock treatment. The course of treatment usually consisted of a series of ten or twelve electroshock treatments. Patients who demonstrated schizophrenic features usually also received twenty-four to forty subcoma insulin shocks. Treatment was considered to have failed if satisfactory improvement was not maintained for at least one year.

The authors have learned to be cautious in drawing pessimistic conclusions at a relatively early phase of the process. The great value of ambulatory treatment after the patient has been discharged from hospital is to be emphasized repeatedly. They have seen patients make unexpected gains in an atmosphere which included understanding relatives. The clinician must learn to be slow in recommending institutional care, especially when the family is willing to assume responsibility in providing adequate home facilities. In cases in which such a provision is economically impossible, it should be the future aim in the treatment of functional psychoses to foster small, homelike state facilities, where a patient will not feel lost and forsaken, and where the sustaining members of the family can continue to visit and give affection and hope.

Shock therapy, in the authors' opinion, is apt to fail if the patient has in the past been a suspicious, socially inadequate person, if there is a long-standing psychoneurotic type of response to life situations and if the patient is in the menopause or postmenopausal period, and has lost a marital partner on whom she has been extremely dependent. The patient who for many years has sought an adjustment through religious identifications often will fail to respond to shock therapy. Their experience has also demonstrated that the manic patient does not respond favorably to electroshock.

The authors are aware of the small number of cases in their series and the lack of statistical proof for their deductions ; however, they have hoped by their report to stimulate others to make similar, comprehensive analyses of the conflicts in patients who have failed to respond to electroshock treatment and of the environmental factors which may have contributed to this failure. When this is done, conclusions may become available which may enable psychiatrists to be more effective and selective in the use of shock therapy in the future.

(Authors' abstr.)

Penicillin Treatment of Neurosyphilis. IV. Tabes Dorsalis.

Fifty-four patients with tabes dorsalis were treated with penicillin : 33 of these received penicillin alone ; 21, penicillin concurrently with therapeutic malaria.

With penicillin therapy alone, the preliminary results from this clinic indicate that the symptoms of 27 per cent. of patients were significantly improved. The effects on the cerebrospinal fluid were favorable in a high percentage of patients, although " inactivity " was not invariably attained. Febrile Herxheimer reactions

occurred only in patients with spinal fluids which gave strongly positive reactions for syphilis and were far less frequent than among patients with dementia paralytica.

With malaria and penicillin therapy, 57 per cent. of the authors' patients were adjudged to have shown significant symptomatic improvement. The effects on the cerebrospinal fluid were uniformly favorable.

A comparison of the results with penicillin alone and those with malaria and penicillin indicates clear-cut superiority for the combined therapy.

Penicillin treatment alone appears superior to therapy of the pre-penicillin era (as defined by the Co-operative Clinical Group) only in respect to its convenience and relative lack of toxicity.

Concurrently administered penicillin and therapeutic malaria is the most effective form of therapy for tabes dorsalis presently available. (Authors' abstr.)

Involuntional Psychosis: Course When Untreated and When Treated with Electric Shock.

The courses of two groups of patients with involuntional psychosis, a control group of 93 and a group of 61 treated by electric shock, are compared. The control group was followed for periods up to fifteen years, with an average of six and one-half years, after discharge; and the shock group, up to four years, with an average of three years.

In the control group, 46 per cent. of the patients recovered spontaneously after a median duration of illness of thirty-one months; 18 per cent. of the patients are still ill; 13 per cent. committed suicide, and 23 per cent. died. About one-half of these deaths were directly attributable to the mental illness. In the shock group, 80 per cent. of the patients were completely recovered or greatly improved for the whole follow-up period. The patients with the paranoid form showed a much poorer response than the patients with melancholia. A few patients who failed to respond to shock therapy did so when a second series was given later. Sixteen patients, or 31 per cent., relapsed after the first series of shock, and 11 of these received additional treatment; 80 per cent. again responded favorably. Shock treatment reduced the residence in hospital from a median of seven months to a median of one and one-half months.

In the control group it was indicated that the following factors had no important relation to the course: a positive family history of psychosis or instability, age of onset of the psychosis, acuteness of onset, sex and typicality of the psychosis. There was evidence that patients with organic factors in the onset died sooner after the onset than did those with mild symptoms.

In the shock group it was indicated that the following factors have little or no influence on the results of treatment: a positive family history of psychosis or instability, age of onset, premorbid personality characteristics, type of onset (endogenous, psychogenic), acuteness of onset, severity of symptoms, duration of illness before treatment, number of shocks and sex.

No factors could be found to characterize the patients who failed to respond to shock or who relapsed after treatment.

It is concluded that electric shock therapy should be applied early to patients with involuntional psychoses, and should be repeated if failure or relapse occurs. It is also concluded that the factors analyzed for a possible relation to the results of shock can be neglected, in general, in efforts to understand the mechanism of shock therapy. (Authors' abstr.)

The Electroencephalogram in Cerebrovascular Disease.

An attempt is made to correlate clinical signs, symptoms and duration of illness with the type of electroencephalogram in 95 cases of cerebrovascular accident.

Some correlation was found to exist between the state of consciousness and the type of electroencephalographic abnormality obtained.

No correlation was found to exist between the presence or absence of gross hemispheric lesions and the electroencephalogram other than that an electroencephalographic focus, when present, corresponded to the anatomic site of the lesion as diagnosed from the clinical findings.

In none of the 14 cases in which convulsive seizures, generalized or jacksonian, occurred did an electroencephalographic pattern indicative of convulsive tendency appear.

Whereas no type of electroencephalographic abnormality is found to be associated only with brain tumor or with cerebrovascular disease, there are certain types of electroencephalograms, i.e., records with asymmetry of delta activity and with a focus of abnormal activity, which are seen much more frequently with tumors than with cerebrovascular disease. Also, irrespective of the type of electroencephalographic abnormality, a diminution in the degree of abnormality in repeat records favors the diagnosis of cerebrovascular disease rather than that of cerebral tumor. (Authors' abstr.)

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Unsuccessful Suicidal Attempts.

1. An unsuccessful suicidal attempt is frequently a serious symptom of a personality disorder.
 2. Although unsuccessful, 60 per cent. could have met with death.
 3. Pseudo or "fake" attempts are more common in the immature age group under 30 years.
 4. The war period decreased both the actual and attempted suicides.
 5. Alcoholism is a precipitating or accelerating factor in over 40 per cent. of cases.
 6. Suicides cannot be traced to lack of intelligence. The problem is definitely one of the emotions.
 7. Inability to work not related to obvious physical cause is an important warning of a personality disorder that may lead to suicidal attempt.
 8. Suicidal attempts, serious or otherwise, are indications of mental tension and are not to be taken lightly. Each case justifies further psychiatric exploration.
 9. There is no direct relationship between the seriousness of the mental disorder and the method employed in the suicidal attempt.
 10. Patients attempting suicide should be sent to secure hospitals rather than to jail cells.
 11. The duty of the general practitioner towards a suicidal patient transcends the ordinary practice of giving first aid. Techniques aimed at life saving, such as stomach pumping, antidote giving, and suturing of inflicted wounds are only the rudiments of treatment.
 12. It becomes the obligation of the attending physician to set the stage for a proper psychiatric follow-up study of each individual suicidal attempt.
- (Authors' abstr.)

Changes in the Electroencephalogram in Subjects under Hypnosis.

1. Hypnosis can be useful in obtaining good electroencephalographic tracings in some individuals where muscle potentials and tension interfere with the obtaining of a good readable record.
 2. The electroencephalogram taken during the hypnotic state but otherwise under standard conditions is apt to show no fundamental change from that taken in the waking state.
 3. Hypnotic modification of seeing does not change the electrocortical activity.
 4. Hypnosis, *per se*, does not affect the cortico electrical physiology as recorded by the electroencephalograph, but changes in the emotional state of some subjects during hypnosis can modify the electrical activity.
- (Authors' abstr.)

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Thyroid Therapy in Some Mental Disorders.

The hypothesis that cerebral anoxia is a necessary and sufficient condition for the development of psychiatric disorder is reviewed in the light of additional experimental and clinical evidence. If the theory is to be entertained, then it should be possible to abolish the psychiatric symptoms by relieving the anoxia. For reasons given, thyroid extract and thyroxin were used to relieve the postulated anoxia in 19 psychotic and 5 psychoneurotic patients. All of the psychotic and 2 of the psychoneurotic patients recovered.

It appears that thyroid replacement therapy, in sufficiently large and sustained doses, improves the prognosis in several types of mental disorder and reduces the number of necessary shock treatments, sometimes to zero. Some diagnostic indications are described, as well as tentative suggestions for a plan of therapy.

It is recognized that thyroid replacement therapy is a crude method of attacking the problem of cerebral anoxia, and that the number of patients described here is small. However, the results appear to be sufficiently promising to encourage further clinical trials.

(Authors' abstr.)

Prefrontal Lobotomy.

1. A conservative and unbiased opinion on prefrontal lobotomy has been presented.

2. The history of psychosurgery parallels that of other fields of medicine—crude attempts at therapy based on superstition and ignorance followed by a strictly scientific approach including observation, anatomy and physiology; and, lastly, rational surgical experimentation.

3. The basis of prefrontal lobotomy rests on the premise that the prefrontal regions of the brain are the centers of affect and emotionality.

4. The chief indications for operation are the mental states of long standing accompanied by affective symptoms and over emotionality which have not responded to more conservative types of therapy.

5. Agitated and depressive states and psychasthenias appear to be most benefited. However, certain cases of dementia praecox and of psychoses with organic brain disease, if well selected, may show definite improvement.

6. Even in well selected cases good results are obtained only about fifty per cent. of the time.

7. Operative deaths are unusual and persistent, significant postoperative complications and intellectual defects infrequent.

8. Adequate convalescent care and rehabilitation, including psychotherapy, are essential.

9. Shock therapy or reoperation may be required if symptoms recur.

10. As a rule the operation is to be considered as a last resort.

(Authors' abstr.)

Incidence of Sensitivity to Mesantoin : Effect of Dosage.

A total of 176 patients were given Mesantoin in varying dosages in order to evaluate the toxic skin manifestations. Epileptic patients were selected, since they were accustomed to taking medication and were more co-operative. There was no significant alteration in the white blood count in any of the author's patients, even the 4 that developed drug eruptions. However, Mesantoin was discontinued as soon as the eruption appeared, which seems to be a safe procedure in institution practice. The very slow, graduated dosage scheme used in Group A, while free of reactions, is definitely impractical. The percentage of patients developing a drug reaction, based on this small group, seems to be about 5 per cent. regardless of the dosage scheme, whether the scale in Group B is followed or the scale in Group D. The fact that the patients had been receiving so much medication previously perhaps explains the fact that only two of them complained of sleepiness on the six grains daily dosage. It appears that Mesantoin is a relatively safe anti-convulsive agent and can be used without any serious complications in 95 per cent. of cases. It appears further evident that the patients, in whom the skin manifestations have developed, may subsequently use this medication without re-appearance of the same type of toxic reaction.

(Author's abstr.)

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A Preliminary Appraisal of Wechsler-Bellevue Scatter Patterns in Schizophrenia.

Subjects used in this study consisted of 67 schizophrenics and 46 non-psychotic patients, all hospitalized in a V.A. Hospital. On the basis of the data presented in this study, it would appear that as yet there are no reliable scatter patterns on the W.-B. Scale for schizophrenic subjects. Possible interpretations are offered for the variation in findings among different investigators.

S. G. DULSKY (Psychol. Abstr.).

A Study of the Hunt-Minnesota Test of Organic Brain Damage at the Upper Levels of Vocabulary.

This study was made to determine the adequacy of the Hunt norms (for determining intellectual deterioration) when testing superior subjects. It is concluded that only negative significance can be attached to results of the Hunt test when administered to persons of superior vocabularies. Predicted deterioration scores for persons with superior vocabularies are far too high. It is suggested that there is little or no relationship between vocabulary score and performance on the deterioration tests for individuals of above average ability.

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Anxiety-Produced Interference in Serial Rote Learning with Observations on Rote Learning after Partial Frontal Lobectomy.

1. Sixteen psychiatric patients, with severe anxiety as the predominant symptom, and sixteen control Ss learned lists of eight nonsense syllables by the anticipation method with massed practice at a four-second rate of syllable presentation. In addition, six cases of bilateral frontal gyrectomy followed the same procedure.

2. The results obtained in the present experiment were in agreement with the predictions from the following hypothesis: The forgetfulness of the anxious patient is due to anxiety-produced interference between the relevant responses and the irrelevant responses generated out of the patient's anxiety-state. The interference value of the tendencies to irrelevant response may be decreased through voluntary effort on the part of the patient.

3. From the results of the present study it appeared that the method of serial learning affords a means of separating the two effects of anxiety-produced interference and intra-serial interference. The locus of the former appeared confined, primarily, to the anterior portion of the series, whereas, as is well known, the maximum of the latter occurs in the middle, or slightly to the right of center.

4. Continued practice in memorization appeared not to reduce the degree of anxiety-produced interference in patients.

5. The fact that end-decrement appeared in the curve for patients with "clinical anxiety" without appearing in the control curve strongly suggests that the phenomenon was anxiety-produced.

6. The gyrectomy curve, compared with the curves for the "non-organic" groups, has the appearance which would be predicted from the hypothesis that frontal lobe damage increases susceptibility to intra-serial interference. The greatest absolute differences occurred in the central portion of the series. Further research with matched groups is required before definite conclusions may be drawn concerning the effects of frontal lobe removal upon degree of susceptibility to associative interference.

(Authors' abstr.)

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*Rôle of Acetylcholine in Synaptic Transmission. <i>Whitteridge, D.</i>	134

Phantom Limbs.

1. A study of some three hundred cases of amputation showed that a phantom limb is a natural and almost universal sequel to amputation.

2. Three kinds of sensory phenomena may appear; (a) Mild tingling, which forms the basic part of the phantom in nearly every case and probably arises in the cerebral cortex; (b) stronger pins and needles induced momentarily by touching a neuroma in the stump; (c) occasionally, superadded sensations which may be disagreeable and painful and probably have a psychogenic basis. Rarely a syndrome resembling causalgia is seen.

3. Special attention has been given to what is termed the "natural phantom," by which is meant the basic sensory tingling, its motor counterpart, the impression of willed movements, and other features. The spontaneous tingling appears in those parts (chiefly thumb, index and great toe) having the largest cortical representation, and the belief that it originates in the sensori-motor cortex is strengthened by its close functional relationship with the motor phenomena. The willed movements also are stereotyped, and are most developed in relation to leading parts of the limb; they are associated with observable contraction of the appropriate muscles in the stump, and their behaviour reflects the fundamental importance of sensation in initiating and controlling voluntary movements. The phantom can be induced and intensified by a variety of reflex factors (for example, micturition) acting centrally.

4. The behaviour and evolution of the "natural phantom" is as if the related cerebral centres were for a time in a state of heightened activity, the later subsidence of which results in telescoping of the phantom and its eventual fading from consciousness, and perhaps also in the disappearance from subconscious levels of its neuronal patterns.

5. Unusual superadded sensations sometimes appear which are peculiar to the patient, and are believed to be psychogenically determined from the highest cerebral level. They may be mild, representing incidents in the patient's past experience, or, rarely, disagreeable—severe spontaneous pain, distorted attitudes, and involuntary spasmodic movements—dominating the phantom. The continuation in the phantom of pre-amputation pain or posture seems to be determined, in many cases at least, by its psychological importance and not by its severity or duration.

6. The phantom cannot, therefore, be considered as a single entity, for its manifestations may be derived from three levels in the nervous system (psychogenic, sensori-motor cortex, and peripheral nerve), and, before operating, it is important to determine to which of these the patient's complaints are most attributable.

7. Peripheral operations on the stump, apart from neurectomy for a sensitive neuroma, usually have no effect on the phantom. Occasionally, in suggestible

patients and following a gratifying operation on the stump, the phantom may be suppressed. (Authors' abstr.)

Physiological Mechanisms Underlying the Electrical Activity of the Brain.

The results are reported of continuous automatic frequency analysis of electroencephalograms recorded from human subjects throughout periods of (1) mild hypoxia without loss of consciousness; (2) mild hypoglycaemia without loss of consciousness; (3) loss of consciousness induced by pentothal anaesthesia; (4) loss of consciousness occurring briefly in one case of fainting.

The data are reviewed in the light of existing hypotheses as to physiological mechanisms, and evidence is presented to show that the observed frequency changes caused by oxygen lack and low blood-sugar level are changes in the same neuronal population rather than a replacement by activity from other cell units. The changes in pentothal anaesthesia are more complex, and are discussed in comparison with those found in loss of consciousness in the absence of the drug.

(Author's abstr.)

Role of Acetylcholine in Synaptic Transmission—Critical Review.

1. The evidence for the mode of action of acetylcholine on nerve and muscle suggests that although it produces depolarization at the nerve muscle junction, it does not do so on nerve or on heart muscle. Its first effect on heart muscle is to reduce the negative after-potential, and to reduce the refractory period.

2. Recent advances in neurophysiology have depended on the analysis of the so-called simple reflex by means of the stimulation of units of uniform function, by recording from as few units as possible and by the accurate analysis of events in time. These methods have as yet hardly been applied to the study of the effects of ACh and anticholinesterases on the central nervous system.

3. The data at present available suggest that the excitation of a motoneurone is due to the cathodal polarizing effect of the synaptic potential set up by the afferent volley. ACh seems to have no effect on this process. The main action of ACh in the central nervous system seems to be the facilitation of repetitive activity, particularly in interneurons. The mode of production of this inter-nuncial facilitation is at present a subject for speculation. (Author's abstr.)

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Temporal and Spatial Distribution of Changes During Spontaneous Seizures in Monkey Brain.

The cortical scar produced by the application of alumina cream is chemically different from the rest of the cortex, as shown by the random fluctuations of its noble metal potential but not by its pH. Occasionally it exhibits electrical seizures of the general form seen in the cortex during *grand mal* seizures. These disturbances may spread through the felt-work of the cortex to contiguous areas, or provoke similar disturbances in remote regions of the cortex and some deeper structures, but only in those to which the discharging region sends axons or collaterals. Changes in the pH and noble metal potential in a given region are the same, and bear the same relation to the electrical discharge in it during the spontaneous seizure of the chronically convulsant cortex, as during similar induced seizures. Like the scars from which such seizures arise in man, the lesion in the monkey's cortex is characterized by a zone of increased vascularity, gliosis and pathological neurons. (Authors' abstr.)

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Aldarson and Bismuth Combined in the Treatment of Neurosyphilis.

(1) One hundred cases of various types of neurosyphilis received 2,400 injections of aldarson and bismuth, concurrently, i.e. 1 gm. of aldarson and 1 c.c. of bismuth salicylate (2 gm., equivalent to 75 mm. metallic bismuth).

(2) Both drugs were given over a period of 24 weeks, once a week, without any interruptions.

(3) There were 41 cases of asymptomatic and 59 cases of symptomatic neurosyphilis.

(4) 43 per cent. improved in cell count; 69 per cent. decreased in mg. per cent. protein; 12 per cent. showed a reversal in Eagle Wassermann in the spinal fluid; 58 per cent. showed reduction in titer of the Eagle Wassermann (70 per cent. of cases, reduction in titer); 15 per cent. showed negative colloidal gold curve and 51 per cent. showed a decrease in the colloidal gold curve (66 per cent. of cases decreased gold curve).

(5) 7 per cent. were completely negative; 5 per cent. increased in all elements; 66 per cent. improvement, which includes the 7 per cent. completely negative; 34 per cent. showed no improvement, which includes the 5 per cent. increased in all elements, in spite of therapy.

(6) No toxic reactions were noted in any of the cases during or after treatment.

(7) Aldarson and bismuth treatment, concurrently, is a safe method in the ambulatory treatment of neurosyphilis. (Authors' abstr.)

AUGUST.

**Studies of Finger Capillaries in Schizophrenia and Manic-depressive Psychoses.*

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Studies of Finger Capillaries in Schizophrenia and Manic-depressive Psychoses.

(1) Mentally and emotionally "normal" individuals show a normal structure of the capillaries of the finger-nail fold.

(2) Mentally deficient children, whose retardation was not caused by environmental factors, show an immature, arrested picture of their finger capillaries.

(3) It was found in previous investigations that constitutionally neurotic individuals show abnormal features of their capillaries, and that patients with idiopathic epilepsy show an immature picture of their capillaries.

(4) The present investigations show that typical schizophrenics and manic-depressives have a definitely different capillary picture in a high percentage of cases; schizophrenics show a picture similar to that seen in normal children prior to the end state of the capillary development. The picture of manic-depressives is similar to that seen in neurotics.

(5) Schizophrenics with mainly paranoid or hallucinatory symptoms show either a mixture of both features, or normal capillaries, or the picture of the manic-depressive group.

(6) The structure of the capillaries is a constitutional feature, and not influenced by the evolution of the psychosis. It does not change during the remissions, and it is independent of the effect of the electric shock treatment.

(7) The immaturity of the capillary picture of schizophrenics corresponds to the traits of immaturity found in the clinical and characterological picture of many schizophrenics. (Authors' abstr.)

Methyl Hydantoin (Mesantoin) in the Treatment of Epilepsy.

A new anticonvulsant drug, 3-methyl, 5,5,phenylethylhydantoin, called "mesantoin" or methyl hydantoin, was tried for periods as long as eight months in

the treatment of 20 patients with epilepsy. Eleven patients were diagnosed as having *grand mal* seizures, 5 as *petit mal* epilepsy, 3 patients had both *grand mal* and *petit mal* attacks, and one had jacksonian epilepsy. In *grand mal*, administration of methyl hydantoin proved more effective than previously used drugs in 7 of 11 patients. The number of *petit mal* attacks was decreased in each of the 16 patients suffering from this condition. Inconclusive results were obtained in the 3 patients with both *grand mal* and *petit mal* due to too brief a period of observation. Dermatitis was caused by the drug in 3 patients, 1 patient complained of gastritis, another experienced an episode of toxic psychosis following administration of only 4 tablets, and 10 patients noted stimulatory effects. Dopiness, gum hyperplasia or depression of the white cell count was not noted by us. In the authors' opinion methyl hydantoin is an effective drug in the treatment of *grand mal* epilepsy, and is especially useful in those cases where phenobarbital causes undue mental depression, or where either phenobarbital or diphenylhydantoin sodium are ineffective. It appears somewhat more effective in the treatment of *petit mal* than diphenylhydantoin, and should be given clinical trial in those cases of either *grand mal* or *petit mal* epilepsy where other drugs are ineffective or not tolerated.

(Authors' abstr.)

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The Action of Acetylcholine and Adrenaline on Flexor and Extensor Movements Evoked by Stimulation of the Descending Motor Tracts.

1. The effect of acetylcholine and adrenaline has been studied separately on extensor and flexor responses produced by stimulation of the descending tracts in the medulla. The observations were made in decerebrate cats in which the sensory roots were divided. The substances were injected intra-arterially so as to pass through the spinal arteries to the cord.

2. The effect of acetylcholine was observed as (a) a simple increase in extensor responses; (b) a simple depression of extensor responses or one which is preceded by a transient phase of facilitation; (c) a simple increase of flexor responses or one which is preceded by a transient phase of depression; (d) a depression of flexor responses. The effects (b) and (c) were commonly observed; the effects (a) and (d) were rare.

3. The effect of a single injection of adrenaline was observed as (a) no effect at all, or a simple depression of extensor responses when the effect of acetylcholine was as in 2 (a); (b) an increase of the extensor responses (corresponding to 2 (b)); (c) a depression of flexor responses (corresponding to 2 (c)); (d) an increase of flexor responses or no effect at all (corresponding to 2 (d)); (e) a restoration of extensor and flexor responses when these had been blocked by acetylcholine.

4. Slow intravenous infusion of adrenaline modified the action of acetylcholine, so that (a) facilitation of extensor response was changed to depression of extensor response; (b) the same depression of extensor responses was produced by a much smaller dose of acetylcholine; (c) a depression of flexor responses by acetylcholine was no longer seen.

5. It is possible to produce flexion by the intra-arterial injection of acetylcholine in the absence of medullary stimulation. This flexion is abolished by adrenaline, which produces extension.

(Authors' abstr.)

Some Effects of Nicotine-like Substances and Their Relation to Sensory Nerve Endings.

1. Arterial injection of nicotine and acetylcholine into the skin or mesentery of cats and dogs causes a centripetal discharge of impulses in the nerves supplying the injected area.
2. The response is not abolished by atropine, and is not elicited by acetyl- β -methylcholine or histamine.
3. Large doses of nicotine and large doses of acetylcholine, after eserine, abolish the sensitivity of the preparation to subsequent doses, but not to mechanical stimuli.
4. The impulses probably arise through the direct chemical stimulation of some part of the terminations of the sensory nerves, although we have failed to obtain them from single Pacinian corpuscles. (Authors' abstr.)

The Effect of Diisopropyl Fluorophosphonate on Neuromuscular Transmission in Cats.

1. In decerebrate cats (2-3 kgm.) the arterial injection of 100-200 μ g. of DFP causes an increase of tension response of the tibialis anterior to single maximal motor nerve volleys. This potentiation is due to repetitive contraction of the muscle fibres and is followed by a period of depressed response, during which the contraction is still repetitive. By intravenous injection DFP is effective only in very large doses (10 mgm./kgm.).
2. During and after the DFP potentiation stimulation of the nerve at 50-200/sec. for 5-10 seconds produces a poorly sustained contraction, which is followed by a transient depression of the response to single nerve volleys; a similar but more permanent depression of the response to single nerve volleys is produced by an arterial injection of acetylcholine.
3. The depressant effects observed after DFP result from an action of acetylcholine, which produces neuromuscular block and a condition of inexcitability of the muscle fibre, both when the acetylcholine is injected or released at the nerve endings.
4. On the denervated muscle an arterial injection of even 2 mgm. of DFP has no effect. A subsequent injection of acetylcholine produces a contracture which is greater and more prolonged than that which occurs in the untreated muscle; it is followed by a profound depression of the response of the muscle to direct electrical excitation.
5. The fact that DFP has a greater affinity for pseudo- than for true cholinesterase must be taken into account when the effect of arterial and intravenous-injections of DFP on neuromuscular transmission are compared with those of eserine. (Authors' abstr.)

Acetylcholine Synthesis in Different Regions of the Central Nervous System.

1. The distribution of the enzyme or enzyme system which forms acetylcholine in the central nervous system of the dog has been determined by examining over forty separate regions with the use of a very sensitive quantitative method for the estimation of acetylcholine synthesis.
2. An attempt has been made to differentiate between cholinergic and non-cholinergic neurons in the central nervous system.
3. The results indicate that some at least of the motor and sensory pathways consist of chains of neurons which are alternately cholinergic and non-cholinergic in character. (Authors' abstr.)

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A Theory on the Identity of Dreams and Disturbed Thinking.

Opposing both mechanistic and psychogenic theories of dreams and psychoneurotic and psychotic symptoms, the author offers a psychiatric theory based on the principles of Hughlings Jackson which would account for these phenomena within a common framework. Immanent in man's consciousness is a substratum of images representing his memories, wishes, etc. (the unconscious). Normally held in check, though utilized in the integrated functioning of the mind, this "sedimentation" may be released in varying degrees depending upon the level of dissolution which affects the field of consciousness. Sleep or the disease process may be regarded as the negative disorder, the resulting dream or symptom representing the positive aspect of the interference with the normal "trajectory of the personality." The dream, neurotic or psychotic symptom is that which is left of the personality when consciousness, the integrating principle, dissolves, and is itself engulfed in the world of images which forms the substratum of the mind.

M. SHEEHAN (Psychol. Abstr.).

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Suicide in Europe and Especially in the Northern Countries.

One hundred thousand people commit suicide annually in Europe, which does not include those of Russia, a country where the toll is no doubt also very high. A review is given of attitudes toward suicide, and what induces this. Denmark leads with 255 annually, and Bosnia and Herzegovina are lowest with only 6 each. The 1927-28 figures are given also, in which Austria is high, and Turkey is lowest with 29. These statistics are shown in map form, with 3 divisions, namely, 200 or more, 100 to 199, and less than 100 annually. In Finland the rate has steadily increased each decade from 1751-60 with 12, to 1931-40 with 194. Similar figures are given for other European countries. Denmark leads all countries over a period of 100 years. The psychology back of this tendency is discussed, with suggestions for preventing it, or at least decreasing it.

O. I. JACOBSEN (Psychol. Abstr.).

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1. Psychiatry, &c.

The Treatment of Schizophrenia with High-vitamin Diet. Schottky, Johannes (Staatlichen Heil- u. Pflegeanstalt Hildburghausen, Ger.). [Allgem. Z. Psychiat., 123, 90-111 (1944).]

A diet consisting mainly of vegetables and fruits and containing no animal protein was administered to schizophrenics, usually for a period of two weeks, while vitamin C and vitamins of the B group were given in large amounts. The results are said to be good, particularly in acute, excited schizophrenics, but no detailed statistics are given.

WARREN M. SPERRY (Chem. Abstr.).

Benzedrine Psychosis: Report of a Case. Schneek, J. M. (U.S. Disciplinary Barracks, Fort Missoula, Mont.). [Milit. Surg., 102, 60-1 (1948).]

The illicit use of benzedrine as a cerebral stimulant by some inmates of a disciplinary barracks is common knowledge for persons associated with these institutions. Many psychological changes occur with its excessive use—irritability, loquaciousness, and increased psychomotor activity are common. A sample case is described—the patient had consumed $1\frac{1}{2}$ benzedrine inhalers within 36 hours. The subject was restless and confused, believed other inmates intended to kill him, heard verbal accusations and experienced a visual hallucination of a knife on the floor. Speech was muddled and mixed with irrelevant data. Within 48 hours he experienced a clearing of consciousness and within a week all symptoms vanished. There was no amnesia for his earlier anxiety, hallucinations and delusions.

G. W. KNOX (Psychol. Abstr.).

On the Appearance of an Unconscious Psychological Activity in the Course of Subtotal Anoxia. Fabre, R., and Rougier, G. [C.R. Soc. Biol. Paris, 141, 77-8 (1947).]

An experiment is reported in which simple commands and questions were given the subject to execute and to answer in an intermediate phase between the loss of consciousness and complete anoxic coma. The tasks were executed and the questions answered by the subject correctly in this subtotal anoxic state. On return to consciousness there is preserved sometimes a vague memory which does not go as far as a recall of whether or not he executed the orders. The author concludes that in the subtotal anoxic state the subject remains capable of appreciable psychological activity, that everything takes place as if the psychophysiological mechanism had developed itself solely in the domain of the unconsciousness.

E. C. SUMNER (Psychol. Abstr.).

Psychoneurosis Based on Organic Ailment Cured by Electric Shock Therapy. Sears, D. R. [*Calif. Med.*, **68**, 81-2 (1948).]

Four cases of psychoneurosis based on organic ailment are cited from the author's experience as indicating that electric shock treatments are effective not only in overcoming depression and other emotional reaction to a physical illness, but sometimes also in alleviating apparently real physical symptoms. Where psychoneurosis arising from organic illness becomes a barrier to physical treatment, electric shock treatment may be effective in returning a patient to a receptive attitude toward physical treatment.

F. C. SUMNER (Psychol. Abstr.).

Psychological Tests in Psychoses in Electric Shock Therapy. Kohlman, Th. (*Psychiatric University Clinic, Vienna, Austria*). [*Wien. klin. Wschr.*, **59**, 140, (1947).]

Thirty female patients (of which 20 schizophrenics were the largest group) were given the Rorschach and Wartegg tests before and after electro-shock therapy. Following the therapy there are (1) increase of perseveration; (2) decrease of intelligence factors; (3) narrowing of Erlebnis type; (4) affectivity greatly decreased; (5) changes in schizophrenia maintained for an average of 6 weeks; (6) depressives tend to return to the pre-shock state; (7) perseveration disappears after 6 weeks, but not the stereotype; (8) Rorschach and Wartegg tests show good correlation. During electro-shock therapy the affectivity of schizophrenics was narrowed, while that of the depressed was broadened. In both intelligence is decreased and symptoms of dementia greatly increased. (Psychol. Abstr.)

The Surgical Treatment of Psychoses. Liebert, E., and Davis, L. [*Illinois med. J.*, **93**, 203-6 (1948).]

Results of prefrontal lobotomy on 38 cases (25 schizophrenics, 6 manic-depressives, and the balance scattered) are described. 25 cases showed improvement (15 schizophrenics, 4 manic depressives, 6 others). Patients selected for operation had been ill for many years and constituted severe behaviour problems in the institution.

C. M. LOUITT (Psychol. Abstr.).

Further Observations on Orbital Prefrontal Lobotomy in Treatment of Chronic Mental Illness. Smolik, E. A., et al. [*Post-Grad. Med. J.*, **3**, 179-84 (1948).]

In an effort to minimize further the amount of brain damage in frontal lobotomy the authors have carried out since 1942 at the St. Louis City Sanitarium a modified technic on 85 patients suffering with chronic mental illness. Through burr openings placed laterally in the skull a blunt instrument is introduced into the subcortex after careful measurement, and section is down to the sphenoidal ridge, the extent and plan of the cut being usually checked by X-rays after the introduction of lipiodol. From this procedure have resulted no deaths, no wound infections, no epilepsy. The incidence of urinary incontinence is reduced to 18 per cent. There is typical gain in weight; there is relaxation and loss of tension. Further advantages of the modified method of the orbital leukotomy are: Limitation of surgical procedure within the brain; diminution of post-operative sequelae; facilitation of retraining and rehabilitation; shortening of recovery time and hospitalization.

F. C. SUMNER (Psychol. Abstr.).

2. Physiology, Biochemistry, &c.

Hyperglycemic Action and Stimulating Effect of Acetaldehyde in Hypoglycemic Coma. Torres, R. [*Bcl. soc. biol. Santiago, Chile*, **4**, 96-8 (1947).]

Patients under insulin shock treatment show return towards normal blood-sugar levels and recovery from shallow or deep coma after intravenous injection of 5-42 ml. 10 per cent. solution of acetaldehyde. Too rapid injection may cause deeper coma.

M. L. WILLIAMS (Chem. Abstr.).

Action of Phosphate on the Neuromuscular Transmission in the Frog. Brown, G. L., and Dias, M. Vianna (Univ. Brasil). [*Anais acad. brasil. cienc.*, **19**, 359-70 (1947).]

The sensitivity of the gastrocnemius muscle of *Leptodactylus ocellatus* to arterial injection of acetylcholine is less than that of *Rana esculenta*. Neuromuscular block is produced by repeated injection of 0.5 per cent. NaH_2PO_4 in Ringer's solution; a reversible block by perfusion of the muscle with 0.2 per cent. NaH_2PO_4 in Ringer's solution. Even then the muscle retains its sensitivity to acetylcholine, thus showing that the effect differs from that produced by curarine. The block, said to be due to failure of acetylcholine production at motor nerve-endings, is similar to that caused by Ca deficiency. M. E. W. TOROK (Chem. Abstr.).

Some Observations on the Modification of the Spinal Potentials of Rana temporaria by Strychnine. Fessard, Alfred (Inst. Marey, Paris). [*Anais acad. brasil. cienc.*, **19**, 349-57 (1947).]

Simultaneous measurement of the action potentials of the dorsal and ventral roots of the spinal cord of *Rana temporaria* after local application of strychnine sulfate (1:10,000 to 1:1,000) showed that the potential of the ventral root was prolonged up to more than 10 seconds, its amplitude increased, and repetition brought rapid fatigue. Only a trace of the same effect can be seen in the dorsal root. This unexpected dominance of the motor over the sensory branch may be explained by the hypothesis that spontaneous activity has its origin in the internuncial neuron. MARIA E. W. TOROK (Chem. Abstr.).

Biochemical Changes in the Brain in Some Organic Diseases and in Alimentary Dystrophy. Kudryavtseva, N. G. [*Byull. Eksptl. Biol. Med.*, **24**, No. 1, 76-7 (1947).]

Organic diseases of the central nervous system cause disturbance of the N metabolism and oxidation processes not only in the diseased parts of the brain, but also in the healthy parts. About 700 analyses of healthy and diseased brains were made. The H_2O content was greater in the affected areas. Determination of the total and non-protein N indicated lower total N in diseases of the central nervous system. Other findings were increased activity of catalase, lower content of ascorbic acid and increased H_2O content in alimentary dystrophy. Conclusion: These considerable biochemical changes are caused by quantitatively insufficient nutrition and hypovitaminoses B and C. W. R. EICHLER (Chem. Abstr.).

Polarization Changes of the Refractivity of Nerves. Bab'skii, E., and Zol'nikova, A. I. [*Byull. Eksptl. Biol. Med.*, **23**, 271-4 (1947) (in Russian).]

The electrotonic changes of the absolute refractivity of nerves are explained by changes in the enzymic hydrolysis of acetylcholine and changes of its concentration in nerve fibers. The lessening of the refractivity at the anode may be explained by an increase in splitting of acetylcholine owing to the activity of cholinesterase. However, if cholinesterase is inhibited by eserine, the d.c. anode does not show any effect on the activity of cholinesterase, and the effect of the anode on the refractivity is, therefore, weaker or even completely disappears. The effect of the cathode on the refractivity is decreased. Atropine destroys the power of nerve tissue to react with acetylcholine and prevents the development of the effects of the anode and cathode. The results indicate that certain physiological effects arising from the action of d.c. on nerve tissue are caused by changes in the content of, and enzyme splitting of, acetylcholine. It was also found that acetylcholine takes part in the formation of the nerve refractivity. This functional change of the state of the excited tissue in consequence of excitation was considered as dependent, although not completely, on the accumulation of acetylcholine in nerve tissue. The effects of acetylcholine, eserine and atropine on the change of the absolute refractivity of nerve are described.

W. R. EICHLER (Chem. Abstr.).

Protein and Nucleotide Metabolism in the Nerve Cell Under Different Functional Conditions. Hyden, H. (Karolinska Inst., Stockholm). [*Symposia Soc. Exptl. Biol.*, **1**, *Nucleic Acid*, 152-62 (1947); cf. *C. A.*, **40**, 937¹.]

Initial development of the nerve cell is the same as that of other somatic cells ; from the multipolar neuroblast, however, it passes through a period of enormous growth. Cyto-chemical analyses have been carried out on 99 embryos (human, rat, and rabbit) in order to determine the amounts of protein and nucleic acids in the cytoplasm of the embryonal nerve cell at various stages. These determinations were based on complete absorption curves from 2,400 to 3,100 Å. At 2,400 Å a distinct absorption maximum appears due to the pyrimidine and purine rings in the polynucleotides of the ribose type. At 2,800 Å a second maximum is visible, due primarily to tyrosine, tryptophan, and phenylalanine. The ratio of concentration of protein to nucleic acid ranged from 3 : 1 to 5 : 1, using unipolar neuroblasts from rat embryos. Anterior horn cells showed 8 : 1 to 11 : 1. It appears that the total amount of proteins in the nerve-cell cytoplasm increases more than 2,000 times during development. If the axon is included, these values are increased to 30,000 to 200,000 times, depending upon the length of the axon. During the whole period of development the young nerve cell contains a large nucleolus, rich in polynucleotides, as well as cytoplasmic nucleotides. This capacity for protein production remains in the adult stage. Near the nucleolus is a region with high absorption at 2,600 Å., which contains proteins rich in basic groups, and small concentrations of ribose nucleotides. Such areas are part of the nucleolus-associated chromatin. Intense muscular activity produces a decrease in protein and nucleic acid of the cytoplasm of anterior horn cells, which is pronounced ; during the first 48 hours after such activity the original values are restored, signifying that nerve-cell function is accompanied by metabolic processes involving quantitative changes in protein and nucleotide content. Acoustic stimulation of ganglion cells of guinea-pigs with tones of various frequencies and intensities produces extensive changes. Exposure to a tone of 6,000 cycles/sec. and intensity of 80 decibels for 3 hours caused a cycle of changes within 3 weeks, including decrease in cellular protein and nucleotides, with most pronounced decrease during the second week, the nucleotides disappearing almost entirely and protein concentration dropping from 25-30 per cent. to 2·8 per cent. During the third week these concentrations are restored. Acoustic trauma produces a decrease in protein which is not completely restored after 8 weeks. Following excision of the axon, nucleotide and protein content are reduced, and after 2 weeks the cytoplasm has lost most of these materials. After a month the protein content begins to be restored. It was noted that the administration of malonitrile induces an increase in protein and nucleic acid in nerve cells. When malonitrile was given to 29 human subjects in doses ranging from 3 to 5 mgm./kgm. body weight varying degrees of beneficial psychic stimulation resulted, some psychotics losing catatonic signs and showing evidence of mental stimulation within 48 hours. In 3 cases of acute depression the symptoms ceased within 1 hour after treatment was started. The amount of protein and nucleotides in the nerve cells of manic-depressives and schizophrenics has been found to be low ; it would appear that there is a correlation between protein metabolism in the nerve cells and function, including psychic function.

JOHN P. CRISPELL (Chem. Abstr.).

New Data on the Biological Action of Sympatholytic Substances. Minz, Bruno, and Peterfalvi, Michel. [*Compt. rend.*, **224**, 1589-91 (1947).]

Previously it was shown that the addition of choline chloride to rabbit intestines in Tyrode solution causes a small increase in the tone, but that the subsequent addition of 5γ of adrenaline per 60 c.c. produces at first a marked decrease in tone and contractions, followed after a short time by an increase in tone to a higher level than before (*C. A.*, **41**, 5606d). Adrenochrome also increases the tone without the preliminary drop. The transformation of choline to acetylcholine is favored by the presence of cocarboxylase (*C. A.*, **41**, 5606b), which was interpreted to indicate that cocarboxylase furnishes from pyruvic acid the necessary acetyl groups for acetylcholine formation, while the action of adrenochrome was explained as indicating the transformation of lactic to pyruvic acid. If these theories are correct, then the addition of either natural (yohimbine, corynanthine) or synthetic (933F) sympatholytic substances should inhibit the tone-increasing effect of either co-

carboxylase or adrenochrome, which was confirmed experimentally. Two interpretations are possible; either a direct inhibition occurs of the enzymic decarboxylation of pyruvic acid in the presence of cocarboxylase, or the esterification mechanism of choline with acetyl radicals is inhibited.

BRUNO VASSEL (Chem. Abstr.).

The Role of the Vegetative Nervous System in the Mechanism of Physiological Regulation of Activity of Carbonic Anhydrase Under Reduced Barometric Pressure. II. Influence of Parasympathicotropic, Sympathicotropic, and Some Other Pharmacological Substances on Carbonic Anhydrase Activity. Khazen, I. M. [Byull. Eksptl. Biol. Med., **23**, 46-8 (1947); cf. C. A., **41**, 2764i.]

The following variations of the activity of carbonic anhydrase (1) of rabbits were observed after administration (subcutaneous) of the following drugs: 1 mgm. atropine, 70-80 per cent. increase; 1 mgm. adrenaline, no substantial change; 1 mgm. morphine, 10-25 per cent. decrease; 1 mgm. strychnine, no substantial change; injections of equal volumes of distilled water also gave no change. Injection of 70-500 γ of histamine gave an increase of 50-300 per cent. When the histamine was given to rabbits which were kept for a month on 100-500 γ daily doses of thiouracil, the histamine effect was essentially nullified and the enzyme activity remained within experimental variations. In a second series of experiments the rabbits were injected with either 1-2 c.c. 0.1 per cent. atropine or 0.5-1.0 c.c. 1:1,000 adrenaline, and after 10 minutes were placed in a vacuum chamber set to simulate 8,000 m. altitude for one hour. The atropinized rabbits showed no change of (1) activity after evacuation of the chamber, while the control animals showed 100 per cent. increase. The adrenaline-treated animals showed a 70 per cent. increase in (1) activity. Several of the latter animals perished during the experiment. Changes of (1) activity were not connected with changes of erythrocyte count.

G. M. KOSOLAPOFF (Chem. Abstr.).

Note on the Synergism of the Central Nervous-system Stimulants. Ahlquist, Raymond P. (Univ. of Georgia, Augusta). [J. Am. Pharm. Assoc., Sci. Ed., **36**, 414-15 (1947); cf. Hazleton and Koppanyi, C. A., **35**, 6314⁸.]

The synergism between the convulsant effects of metrazol with nikethamide and with strychnine in albino rabbits is partially additive, owing to differences in points of action.

H. BERNARD (Chem. Abstr.).

Clinical Experience with the New Method for Titration of Protective Enzymes. Winkler, Walter (Univ.-Nervenklinik, Marburg, Ger.). [Allgem. Z. Psychiat., **123**, 278-312 (1944).]

The method of C. A., **37**, 5097², was applied to the determination of protective enzymes in the urine of 60 patients with a variety of diseases, mostly related to endocrine disturbances. In most of these the enzymes were also determined in the blood serum by a similar procedure; precipitation with 15 volumes of Me_2CO and extraction with a trypsin solution as in the urine method. Various organs of internal secretion were used as substrates. In most of the patients with definite endocrine disturbances protective enzymes were found in both urine and serum, and usually, though not always, they appeared to be specific for the particular organ or organs involved; for example, an enzyme specific for the pituitary was found in a patient with a tumor of that organ. The method is of diagnostic value.

WARREN M. SPERRY (Chem. Abstr.).

Studies on Choline Acetylase. IV. Effect of Citric Acid. Nachmansohn, David, and Weiss, Michael S. (Columbia Univ.). [J. Biol. Chem., **172**, 677-87 (1948); cf. C. A., **41**, 1721a.]

From the acetone-dried powder of squid head ganglia was prepared a highly active choline acetylase (I) preparation which caused the formation of up to 150 mgm. of acetylcholine per gm. protein per hour. This degree of purity of (I) referred to the protein is 14-15 times as great as previous preparations. The activity of (I) is lost upon dialysis, but can be completely restored by the addition of choline, acetate, K^+ , Mg^{++} , coenzyme, adenosinetriphosphate, eserine and cystine. L-

glutamic acid and α -ketoglutaric acid have no effect. Acetate is used directly for the acetylation, as shown by the marked increase in the rate of formation of acetylcholine upon the addition of acetate. Citric acid had an inhibitory effect upon both dialyzed and undialyzed (I) possibly through the removal of Mg^{++} necessary for transphosphorylation. This inhibition could not be overcome by increasing the concentration of adenosinetriphosphate or coenzyme. The K salt of 2-methyl-1, 4-naphthoquinone-8-sulfonic acid had a strong inhibitory effect. K^+ can be replaced by Rb^+ , but not by Na^+ or Li^+ .

A. JEROME GANZ (Chem. Abstr.).

Some Actions of Potassium Chloride at the Neuromuscular Junction. Altamirano, M., and Huidobro, F. (Catholic Univ. of Chile, Santiago). [Am. J. Physiol., **152**, 53-65 (1948).]

The action of KCl injected into the terminal portion of the abdominal aorta was studied in the normal quadriceps and in the normal and denervated soleus of the cat. KCl causes contraction of the soleus which has been denervated 6-14 days previously. In the quadriceps or soleus stimulated indirectly KCl produces contraction potentiation or depression of the response of the muscle depending on the frequency of stimulation and the dose. In the soleus denervated 6-14 days previously and stimulated directly by electric shocks, KCl produces the same effects as in the normal soleus stimulated indirectly. In the quadriceps stimulated directly at low frequency KCl may have effects which are synergistic to those produced by a previous injection of prostigmine. KCl has a decurarizing action. In both the denervated and the normal soleus KCl produces either depression or potentiation of the contractions evoked by injections of acetylcholine, depending on the time interval between the two injections. In the normal soleus prostigmine increases the contraction produced by KCl, but this effect is not observed in the soleus denervated 6-14 days previously. A tetanus produced by indirect stimulation increases the response of the normal soleus to KCl. Acetylcholine sensitizes the normal or denervated soleus to a subsequent injection of KCl. The effects of KCl are discussed in relation to the mechanism of action of acetylcholine at the neuromuscular junction.

E. D. WALTER (Chem. Abstr.).

Camphor-ether Mixture for Epilepsy Diagnosis. Kalyapin, G. F. (Samarkand Med. Inst.). [Nevropatol. i Psikhiat., **15**, No. 6, 72-3 (1946).]

Intravenous injection of 0.6-1.2 c.c. ether-camphor mixture leads to typical seizures only in genuine epileptics.

G. M. KOSOLAPOFF (Chem. Abstr.).

Influence of Electro-spasm on the Carbohydrate Metabolism in Schizophrenia. Serezhskii, M. Ya., and Lando, L. I. [Nevropatol. i Psikhiat., **15**, No. 6, 19-21 (1946).]

A single electric shock leads to an increase of blood sugar up to 56 per cent. Repeated shocks give similar increases each time in about 50 per cent. of cases, the others give random responses. Lactic acid rises by 200-800 per cent. in single-shock treatments; the effect is gradually lost on repeated treatments.

G. M. KOSOLAPOFF (Chem. Abstr.).

Studies of the Metabolic Exchange of Cerebral Centers with the Aid of Artificial Radioactive Phosphorus (P^{32}). Roeder, Fritz (Kaiser-Wilhelm Inst., Munich, Ger.). [Z. ges. Neurol. Psychiat., **178**, 288-344 (1945).]

Small quantities of inorganic phosphate containing P^{32} were injected intramuscularly into 15 dogs, 31 rabbits and 33 guinea-pigs. After intervals of time (72 hours in some experiments, not stated in others) the animals were killed and the total P and P^{32} concentrations were determined in many areas and structures of the brain, and in other organs, especially liver, muscle and blood, for comparison. In most of the dog experiments from 15 to 30 different tissues were compared. The results are reported as specific activity calculated as the ratio of P^{32} to total P in the tissue. Usually the specific activities of brain tissues were much smaller than those of other organs, but in some dog experiments the specific activities of the globus pallidus were as high as that of the liver. In other experiments the specific activity of the globus pallidus was lower than that of the other structures of the

brain. The specific activity of the occipital lobes was high in some experiments but not in others, and there were other similar variations. Some P^{32} was found in lipides, extracted from brain by ether in 3 rabbits which had received P^{32} 24 or 72 hours before they were killed.

WARREN M. SPERRY (Chem. Abstr.).

Carbonic Anhydrase in the Pallium of Primates Compared with that of Lower Mammals. Ashby, Winifred (Saint Elizabeth's Hospital, Washington, D.C.). [Proc. Soc. Exptl. Biol. Med., **67**, 17-22 (1948).]

In the dog, cat, hog, horse, sheep, cow and rabbit the brain cortex has a higher carbonic anhydrase activity than the underlying white matter; in man and rhesus monkey the opposite is true.

L. E. GILSON (Chem. Abstr.).

Hormone of Rest. Medvedeva, Nina (Inst. Exptl. Biol. Pathol., Kiev, U.S.S.R.). [Acta Med. Scand., **130**, 97-105 (1948).]

Corticalin is a true hormone which is extracted from the adrenal cortex by trituration with acidulated H_2O . The substance is precipitated with Na stearate. On parenteral injection it causes a marked fall in blood pressure and severe hypoglycemia which, unlike insulin hypoglycemia, never leads to convulsions. The preparation is devoid of any type specificity. Its principal function is to increase the synthetic processes of carbohydrate metabolism. Since it does not cause any increase in lactic or keto acid in the blood, it does not apparently affect the glycolysis. But it reduces oxidation (sugar?), since under its influence the production of CO_2 is markedly decreased. Under its influence the glycogen of tissues in normal animals is increased; in rats the liver and muscle glycogen content was doubled. The resynthesis of glycogen in working muscles is accelerated, and this is found even in adrenalectomized animals in which the muscle is incapable of resynthesizing the used-up glycogen. The phosphagen content of various tissues is increased in treated animals; that of the heart and liver is about doubled, of kidney tripled, of muscle more than quadrupled. Whereas the phosphagen content of muscle or liver decreases during fatigue and barely returns to the resting level after one hour repose, in animals treated with the corticalin the synthesis during the phase of repose is several times higher than in an untreated animal. Similarly the hexose phosphate concentration in heart, muscle and intestine is reduced to about one half or less in adrenalectomized rats, but is increased (25 to 50 per cent.) in rats treated with corticalin. Here, again; the hexose phosphate concentration is greatly decreased during work, but if corticalin is administered before work the concentration in fatigued animals is 3 to 5 times as large as in the fatigued untreated animals. Protein metabolism is practically unaffected by corticalin. Its action differs from that of the cortical steroids in that it has no influence on salt or water metabolism. Its only known function is the synthetic phase of carbohydrate metabolism, and its important role is the reparation during muscle work.

S. MORGULIS (Chem. Abstr.).

Inhibition of Coupled Phosphorylation in Brain Homogenates by Ferrous Sulfate. Racker, E., and Krimsky, I. (New York Univ. Coll. of Med., New York, N.Y.) [J. Biol. Chem., **173**, 519-33 (1948).]

The inhibiting effect of $FeSO_4$ on brain glycolysis is due to an inhibition of the coupled phosphorylation catalyzed by the phosphoglyceraldehyde-oxidizing enzyme. A partial inhibition of this enzyme leads to the inhibition of adenosinetriphosphate synthesis, which is necessary for the formation of fructose 1,6-diphosphate from glucose. The glycolytic activity of a brain homogenate which has been inactivated by the addition of proteolytic enzymes can be restored through the addition of the phosphoglyceraldehyde-oxidizing enzyme prepared from yeast or muscle. If the inactivated brain homogenate is dialyzed against 0.1 M KCN for 5 days the inactivating factor is lost, but reactivation can be established by the addition of $FeSO_4$ and cysteine.

GERTRUDE E. PERLMANN (Chem. Abstr.).

Blood-sugar Regulation in Brain Tumours. I. Studies in Patients. Matsuda, Masani (Nippon, Geka Hokan). [Arch. Japan. Chir., **19**, 423-57 (1942).]

The blood sugar in 37 cases of brain tumours varied within the normal range. A particular level did not correlate with a particular location of a tumour. Oral

administration, not intravenous injection, of 30 gm. glucose induced greater or less deviations in the blood-sugar curve than normal, particularly in tumours of the posterior fossa. Oncolectomy had a similar effect owing perhaps to surgical trauma. These results support Claude Bernard's assumption that the blood-sugar regulating centre exists in the region of the fourth ventricle. Post traumatic or post encephalitic cerebral atrophy in lesions other than tumours caused abnormal blood-sugar curves more frequently than genuine epilepsy, which is found to be free of atrophy by pneumoencephalography or by surgical exploration.

J. G. YOSHIOKA (Chem. Abstr.).

Vitamin A and Carotene Contents of Blood Serum in Various Nervous Disorders. Huszák, Istvan, and Geréb, Tibor (Univ. Nerven- u. Geisteskrankheiten, Szeged, Hung.). [*Intern. Z. Vitaminforsch.*, **19**, 330-5 (1948) (in German).]

In funicular myelosis, and to a lesser extent in polyneuritis, there is a lowered vitamin A content of the serum. The vitamin A content is normal in disseminated sclerosis and in syphilis, but falls after fever treatment.

LEOPOLD SCHEFLAN (Chem. Abstr.).

An Evaluation of Curare in Spasticity Due to Spinal Cord Injuries. Kuhn, Robert A., and Bickers, Donald S. (Cushing Veterans Admin. Hosp., Framingham, Mass.). [*New Engl. J. Med.*, **238**, 615-22 (1948).]

No definite relief of spasms in 17 paraplegic or paraparetic patients with traumatic lesions of the spinal cord was obtained from intramuscular injections of 175 mgm. d-tubocurarine chloride in 1 c.c. of oil and white wax every 48 hours for 10 doses. Diplopia and pitting edema of the hands and feet (the latter a complication of curarization not previously reported) were toxic symptoms found in this series, and not in 17 controls given an equal volume of physiol. saline solution. In other groups prostigmine and atropine injections were unsuccessful, local injection of spinal nerves with procaine or related preparations provided a very brief relief, and intramuscular injection of aqueous curare gave transient beneficial effects, nullified by incapacitating toxic symptoms.

MARION HORN PESKIN (Chem. Abstr.).

Changes in the Activity of Some Digestive Organs in Cortical Inhibitory States. Nekachalova, I. Ya. [*Byull. Eksptl. Biol. Med.*, **23**, 310-12 (1947).]

Nekachalova's investigations refute the viewpoint of the supporters of the "peripheral" nature of exhaustion of the salivary glands, and confirm the theory that exhaustion is the result of inhibitory states of the cortex of the brain, in proof of which six series of experiments were carried out: (1) Feeding very small amounts at short intervals for 3 hours did not impair the activity of the salivary glands. (2) Continuous washing of the stomach with warm physiol. NaCl solution caused rather stable exhaustion, and restoration of normal function required 15-18 days instead of the normal 5-6 days. (3) Changing the conditions of the experiment and the nature of the stimulants by feeding different stimulants (milk, sugar, meat, powdered dog biscuit) every 30 mins. for 3½ hours did not bring about symptoms of exhaustion. (4) Feeding small amounts for a few seconds followed by rest for about one minute, during which time a biscuit was placed in front of the animal for natural stimulation, decreased the saliva, and exhaustion of the glands followed, since the solids in saliva sharply decreased as a result of an inhibitory state of the cortex of the brain. (5) Long stimulation by natural means was tried for several days. This caused such an exhaustion that the normal state of saliva was not regained for a year. (6) On the assumption that the change in the function of the salivary glands was due to central inhibitory states, the usual method of restoration by introducing 0.5 per cent. HCl into the mouth was employed. After 2-3 applications normal function was restored. In unstable exhaustion one application was sufficient.

W. R. EICHLER (Chem. Abstr.).

Histochemical Distribution of Peptidase Activity in the Central Nervous System of the Rat. Pope, Alfred, and Anfinsen, Christian B. (Harvard Med. School, Boston). [*J. Biol. Chem.*, **173**, 305-11 (1948).]

Tissue samples (4 mm. in diameter) were punched from the cerebrum, brain stem, and cerebellum of adult rats (also coronal sections of the spinal cord). Micro-

tome sections of each sample were taken for histological examination, extraction with 30 per cent. glycerol at pH 7.0, dry weight determination (38-71γ). The extracts, including the tissue, were used as experimental and autolysis control preparations for determining the amount of cleavage of 6.9 c.mm. of a 0.2 M solution of DL-alanylglycine in 0.0343 N NaOH at 38°. Peptidase activity of each tissue as a function of time of hydrolysis is presented graphically. The cerebral and cerebellar tissues have a higher degree of peptidase activity than do those of spinal cord and brain stem.

J. P. DANEHY (Chem. Abstr.).

Electrical Transmission at Nerve Endings. Singh, Inderjit, and Singh, Sunita Inderjit. [Current Sci. (India), **14**, 244-5 (1945).]

The frog gastrocnemius was stimulated alternately through its nerve and by acetylcholine every 5 minutes. Out of 12 gastrocnemii 6 were insensitive to acetylcholine (1 : 10³), and the other 6 gave feeble responses with 1 × 10⁻⁵ M, but they were all hyperexcitable to nerve stimulation or to acetylcholine. In the absence of Ca the muscle first became hyperexcitable to nerve stimulation and acetylcholine; after 15 minutes it became inexcitable to the former, but remained hyperexcitable to the latter. As the Ca concentration was increased the excitability to nerve stimulation increased, and that to acetylcholine decreased, the optimum concentration of Ca for the former being 0.02 M CaCl₂. Replacement of the Cl of the saline with Br⁻, NO₃⁻ and (I) at first increased the excitability to both, but after 10 minutes affected them in opposite directions.

B. A. (Chem. Abstr.).

The Effect of Ethyl Alcohol upon Frog Nerve. Gallego, Antonio (Rockefeller Inst., New York, N.Y.). [J. Cellular Comp. Physiol., **31**, 97-106 (1948).]

Alcohol is a depolarizing agent. At concentrations of 1-2 M it lowers the membrane potential below the critical excitability level. However, alcohol has no demonstrable direct effect on the excitable mechanism, since the ability of nerve fibers to conduct impulses is restored by raising the membrane potential by means of an externally applied anodal current. The effect of alcohol begins to become irreversible when the demarcation potential between treated and untreated segments exceeds 12.5 mv. There is no recovery if the demarcation potential reaches 20 mv.

H. L. MASON (Chem. Abstr.).

Lipoid Fractions in Neurinomas. Muntoni, Ennio (Univ. Firenze, Italy). [Sperimentale, **98**, 612-18 (1947).]

Histochemical studies indicate that all neurinomas contain phosphatides, cholesterol, neutral fat and fatty acids. Malignant neurinomas are richer in lipoids, especially phosphatides.

A. E. MEYER (Chem. Abstr.).

Free and Total Thiamine in the Peripheral Nerves and the Central Nervous System of Several Mammals. Muralt, G. de (Inst. Physiol., Berne, Switz.). [Intern. Z. Vitaminforsch., **19**, 74-101 (1947).]

Determination was made of both the free and the total thiamine of peripheral nerves and of the central nervous system of the rat, rabbit, dog and calf. Nerve or cerebral substance was hydrolyzed for 1 hour in N HCl at 98° without decomposition of the vitamin and without its liberation from cocarboxylase. The free thiamine in this tissue extract was determined by the thiochrome reaction. Total thiamine was determined by neutralization of the tissue extract to pH 5, addition to a culture of *Phycomyces*, incubation for 10 days at 17°, collection of the growth, drying for 1 hour at 100°, and weighing. The method was accurate to 1 × 10⁻⁹ gm. = 15 per cent. The N content of the tissue extract had no appreciable influence on the growth of the *Phycomyces*. In the rabbit the total thiamine concentration in the nerves, especially in the central nervous system, was considerably less in winter than in spring or summer, while the free thiamine concentration did not change. The rat showed no seasonal variations. In all the animals both free and combined thiamine were present, the free thiamine concentration was approximately the same in the central system and in the peripheral nerves, while the total thiamine concentration was much greater in the central system than in the peripheral nerves.

JOSEPH S. HEPBURN (Chem. Abstr.).

Correlation Between the Lactose Content of Milk and the Cerebroside and Choline Content of Brain. Sadhu, D. P. (Univ. of Missouri, Columbia). [*J. Dairy Sci.*, **31**, 347-51 (1948).]

Nine species of mammals have been examined for the cerebroside and choline contents of their brains. Brain cerebroside show a high positive correlation with the lactose percentage of the respective milks. There is a slight positive correlation between choline content of brains and the lactose content of the mothers' milk. It is suggested that sphingosine can reversibly take up galactose or choline-phosphoric acid to form cerebroside or sphingomyelin, and thus cerebroside may function as choline spacers. There is an increase of cerebroside with age and gestation. There is no significant difference in the cerebroside distribution between cortex and medulla of the brains of the species studied.

A. H. JOHNSON (Chem. Abstr.).

Microchemical Studies on the Nervous System. V. The Sulfur Compounds of Nerve During its Degeneration. May, Raoul M. (Sorbonne, Paris). [*Bull. soc. chim. biol.*, **29**, 1035-42 (1947); cf. *C. A.*, **35**, 3301⁹.]

Cut sciatic nerves of dogs and rabbits were analysed at intervals during degeneration. Total S, lipide S, protein S and water-soluble S all showed marked increases, especially during the first 7 days.

L. E. GILSON (Chem. Abstr.).

Phenylpyruvic Oligophrenia. The Position of the Metabolic Error. Jervis, George A. (New York State Dept. Mental Hyg., Thiells). [*J. Biol. Chem.*, **169**, 651-6 (1947).]

DL-phenylalanine (I), L-tyrosine (II) or phenylpyruvic acid (III), fed to fasting normal human subjects, rabbits, or cats, led to a significant increase of Millon-reacting substances in the blood. When fed to fasting patients suffering from phenylpyruvic oligophrenia, (I) and (III) caused no increase in Millon-reacting substances, whereas tyrosine did. It is concluded that the biochemical error in phenylpyruvic oligophrenia consists of a block in the normally occurring process of hydroxylation of phenylalanine to tyrosine.

JULIA O. HOLMES (Chem. Abstr.).

Phenylpyruvic Oligophrenia. IV. Method for Determining Phenylpyruvic Acid in Urine. Polonovski, M., Desgrez, P., and Delbarre, F. (Univ. Paris). [*Bull. soc. chim. biol.*, **29**, 1049-54 (1947).]

One c.c. of slightly acid urine (pH 5-6) is diluted to 50 c.c. with distilled water, 1 c.c. saturated $\text{Fe}(\text{NH}_4)(\text{SO}_4)_2$ solution is added, and the green color is measured photometrically, preferably with a red light filter. A correction curve is necessary.

L. E. GILSON (Chem. Abstr.).

Alterations in Metabolism of Some Aromatic Amino Acids in Acute Polyneuritis. Lollis, Cesare De (Univ. Catania, Sicily). [*Boll. soc. ital. biol. sper.*, **23**, 1011-13 (1947).]

The daily urinary elimination of water and ether-soluble Millon-reactive substances was increased in polyneuritic persons with daily values of 180-300 mgm., in contrast to 17-149 mgm. in normal persons.

HELEN LEE GRUEHL (Chem. Abstr.).

Cleavage of Phospholipides by Brain Tissue. Sperry, Warren M. (Columbia Univ.). [*J. Biol. Chem.*, **170**, 675-86 (1947).]

Homogenates of rat-brain tissue in saline-carbonate buffer were incubated at 37.5° with shaking for 4 hours. A consistent decrease averaging 8 per cent. (varying from 3 to 17 per cent.) in the amount of P extractable with lipide solvents took place. Incubation for 24 hours caused a greater decrease in phospholipides. This decrease in extractable P was the result of a cleavage of phospholipides by a mechanism present in brain tissue.

IVAN A. WOLFF (Chem. Abstr.).

Brain and Muscle Potassium in Relation to Stressful Activities and Adrenal Cortex Function. Hoagland, Hudson, and Stone, David (Worcester Foundation for Exptl. Biol., Shrewsbury, Mass.). [*Am. J. Physiol.*, **152**, 423-35 (1948).]

Small (0.5 mgm. per day) doses of desoxycorticosterone (I) or of Δ^5 -pregnenolone (II) did not affect brain K in normal rats; (I), but not (II), reduced the concentration of muscle K by 6.2 per cent. Uncompensated adrenalectomy increased the concentration of brain K by 24.0 per cent., and of muscle K by 37.5 per cent. (II) (0.5 mgm. per day) lessened the increase in concentration of brain K in adrenalectomized rats by 10.0 per cent., and of muscle K concentration by 12.0 per cent. The stress of prolonged swimming reduced the concentration of brain K by 4.4 per cent., and that of muscle by 6.1 per cent. These, together with the foregoing results, were all statistically significant. (II) also tended to prevent the decrease of K concentration in muscles of animals forced to swim. (I) significantly augmented the decrease of concentration of muscle K in swim-stressed animals. The results are discussed in relation to effects of K on tissue excitability and to the antifatigue action of pregnenolone.

E. D. WALTER (Chem. Abstr.).

Specific Sympathomimetic Substance in the Brain. Raab, W., Peyser, P., and Giguee, W. (Univ. of Vermont, Burlington). [*Am. J. Physiol.*, **152**, 324-39 (1948).]

A sympathomimetic amine was isolated in relatively large quantities from all parts of the human brain and from animal brains. This substance has some chromogenic and most pharmacodynamic properties in common with adrenaline and with noradrenaline, but it also differs from both of these in some significant respects. It has been designated as encephalin.

E. D. WALTER (Chem. Abstr.).

The Lecithin, Cephalin, and Sphingomyelin Content of Serum. I. As Indicated by the Choline-phosphorus and Nitrogen-phosphorus Ratios. Sinclair, R. G. (Queen's Univ., Kingston, Can.). [*J. Biol. Chem.*, **174**, 343-53 (1948).]

The lipides were isolated from large volumes of serum or plasma, and fractionated into acetone-soluble and acetone-insoluble fractions. The latter was purified by dialysis to remove nonlipide impurities and analysed for choline P and N. The crude acetone-insoluble lipides contained 21-40 per cent. diffusible, non-lipide impurities which were rich in N and included some choline. The choline to P ratio was used as a measure of the percentage of lecithin plus sphingomyelin. The difference between the N : P ratio and 1.0 was assumed to measure the percentage of sphingomyelin. The data of Taurog *et al.* (*C. A.*, **39**, 9647) are confirmed in that the phospholipides in human and dog plasma are mainly choline-containing, and that cephalin is at most a minor component—3-8 per cent. This is also true for serum phospholipides of beef and pig, but turkey serum contains about 20 per cent. cephalin. Sphingomyelin makes up 15-32 per cent. of the total phospholipides.

II. As Indicated by the Amino Nitrogen and Non-diffusible Phosphorus Content after Differential Hydrolysis of the Acetone-insoluble Lipides. [*Ibid.*, 355-60.]

The method of Schmidt *et al.* (*C. A.*, **41**, 3158f) was adapted so that after alkaline hydrolysis the H_2O -soluble glycerophosphate, choline, and ethanolamine could be separated from the non-hydrolyzed sphingomyelin by either solvent fractionation or by dialysis. The amino N of the H_2O -soluble or diffusible fraction was taken as a measure of the cephalin, and the P of the H_2O -insoluble or non-diffusible fraction as a measure of the sphingomyelin. The acetone-insoluble lipides, after purification by dialysis, were hydrolyzed with N KOH at 37°. From the water-soluble amino N found it was calculated that cephalin is present to about 3-6 per cent. of the total phospho-lipides in human plasma and pig serum, and 16 per cent. in turkey serum. No cephalin was found in beef or dog serum. The sphingomyelin P was found to make up 15-32 per cent. of the total P. The values for sphingomyelin are in agreement with those calculated from the N : P ratio (*cf.* above).

A. DIETZ (Chem. Abstr.).

D- α -Amino Acid Oxidase in the Central Nervous System. Mitolo, Michele (Univ. Bari, Italy). [*Boll. soc. ital. biol. sper.*, **23**, 983-4 (1947).]

The D- α -amino acid oxidase was determined by the production of NH_3 from the D-amino acids alanine and phenylalanine through the action of minced nerves.

The oxidase was present in some sections of the nervous system (particularly in the cerebral gray matter) of frogs, hens, guinea-pigs, rabbits, rats and roosters, but was absent in other portions. It was not present in the nervous system of greenfinches, ducks or cats.

HELEN LEE GRUEHL (Chem. Abstr.).

The Cerebrospinal Fluid in Epileptics and Changes Therein after Spontaneous and Induced Seizures. Boszorményi, Z. (Pázmány Péter Univ., Budapest, Hung.). *Confinia Neurol.*, **5**, 281-97 (1942) (in French).]

In 80 of 380 epileptics the protein concentration, colloid precipitation test or both were abnormal in the cerebrospinal fluid. No relation could be established between the findings and the duration of disease, the frequency of attacks, or the proximity of the last seizure. In 39 patients the fluid was examined before and after electric shock; in about 25 per cent. there was an increase in the number of cells, and protein concentration and characteristic changes in the colloid precipitation curve. In 6 of 8 epileptics and 2 of 4 schizophrenics the permeability of the blood-spinal fluid barrier, measured by the NaBr method, was increased after electric shock.

WARREN M. SPERRY (Chem. Abstr.).

Ultraviolet Spectrographic Studies on Cerebrospinal Fluid. Spiegel-Adolf, Mona (Temple Univ., Philadelphia, Pa.). [*Confinia Neurol.*, **7**, 77-88 (1946) (in English); cf. *C. A.*, **41**, 1032f.].

Ultraviolet spectrographic examination of cerebrospinal fluid indicates the presence of abnormal proteins in general paresis, and of nucleic acids in the case of some patients with convulsive disorders, cerebral concussion, or brain tumor. The presence of nucleic acids was shown in the fluid from dogs which had electrically induced convulsions; this finding was confirmed by a chemical test.

W. M. SPERRY (Chem. Abstr.).

Iron Content of Blood Serum and of Cerebrospinal Fluid in Parkinsonism. Ferroni, A. (Univ. Catania, Italy), and Indovina, I. [*Boll. soc. med. chir.*, Catania, **13**, 9 pp. (1945); cf. *C. A.*, **42**, 1652h.].

Determined by the method of Heilmeyer and Plottner (*C. A.*, **31**, 5426³), Fe in the blood serum in 20 cases of Parkinsonism was nearly normal; in a small majority of cases it was lower than normal. In 8 of 11 cases Fe in the spinal fluid was higher (average 46% per cent.) than normal. Two hypotheses for such variations are suggested.

C. SCANDURA (Chem. Abstr.).

Determination of Iron in the Cerebrospinal Fluid. Buscaino, G. A. (Univ. Catania, Italy). [*Progresso med.*, **2**, 6 pp. (1946).]

As determined by the Heilmeyer method (*C. A.*, **31**, 5426³), the average of 45 determinations of Fe in the cerebrospinal fluid was 34% per cent. In infective diseases of the nervous system and in progressive paralysis the Fe contents were, respectively, 20 and 18% per cent. In schizophrenia 38-65% per cent. was found. The cause of these variations is discussed.

C. SCANDURA (Chem. Abstr.).

An Investigation of the Protein of Cerebrospinal Fluid by Photoelectric Measurement of the Xanthoproteic Reaction. Duensing, Friedrich (Univ. Göttingen, Ger.). [*Z. ges. Neurol. Psychiat.*, **178**, 218-39 (1945).]

Precipitate the total protein of cerebrospinal fluid in a calibrated centrifuge tube by CCl_3COOH , centrifuge, and dissolve in 0.1 N NaOH. Add concentrated HNO_3 and heat 5 minutes at 100°. Add 33.3 per cent. NaOH to a definite volume, filter, and read the yellow color in either a step photometer or a photoelectric colorimeter. With the latter, protein can be determined in 0.5 ml. of fluid. Determine globulin in the same way except that it is precipitated by saturated $(\text{NH}_4)_2\text{SO}_4$. Albumin and globulin give different extinction curves because they differ in content of aromatic amino acids. Therefore, the results are calculated from curves determined on serum albumin and globulin. The method for total protein was compared with the direct centrifugation method of Kafka (*C. A.*, **41**, 6915g) on 300 cerebrospinal fluids. In 257 the three tests were in qualitative diagnostic agreement. In 134 of these the two methods showed a normal protein concentration

and the quantitative agreement was fairly good. The colloid reactions also were normal. In 123 the two methods showed an abnormally high protein concentration, but there was frequently poor quantitative agreement, especially when the protein concentration was abnormally high. The colloid reactions also were abnormal. In the remaining 43 samples the two methods for protein and the colloidal reactions were not in qualitative diagnostic agreement. In most of these the new protein method and the colloid reactions agreed in showing either normal or abnormal fluids, while the centrifugation method gave the opposite result. Some of the discrepancies may be caused by variations in the content of aromatic amino acids in protein.

W. M. SPERRY (Chem. Abstr.).

Simple Determination of the Globulin-albumin Ratio in Spinal Fluid. Schwab, Arthur O. (Inst. biol. pesquisas tecnol., Curitiba, Brazil). [Arquiv. biol. tecnol., **1**, 33-8 (1946).]

The turbidity from Nonne's reaction is compared with the turbidity from half the liquor and a supersaturated solution of $(\text{NH}_4)_2\text{SO}_4$ to determine the ratio. The method is simple and clinically satisfactory.

MORRIS SLAVIN (Chem. Abstr.).

The Presence of Specific Protective Proteinases in Cerebrospinal Fluid and Their Preparation in Crystalline Form. Abderhalden, Rudolf, and Elsaesser, Karl Heinz (Martin-Luther-Univ., Halle, Ger.). [Allgem. Z. Psychiat., **123**, 83-9 (1944).]

Crystalline preparations with protective proteinase (I) activity were obtained from cerebrospinal fluid (C.S.F.) by the following procedure: The C.S.F. was dialyzed 48 hours against flowing conditioned water and 14 hours against distilled water, and then centrifuged. The supernatant fluid was concentrated slowly *in vacuo* at 35° to 1/8 to 1/10 of the original volume. (I) crystallized in beautifully formed, large crystals, probably monoclinic, and in small polymorphic crystals. Preparations from healthy and schizophrenic subjects appeared the same, and showed no differences from crystals isolated previously from patients with Huntington's chorea (*Fermentforsch.*, **17**, 213 (1943)). All preparations were colored blue violet by ninhydrin, dissolved with difficulty in water or 0.1 N NaOH, and were fairly soluble in 0.1 N HCl. The crystalline preparations or original C.S.F. from healthy persons gave no activity when tested against various parts of the brain as substrates with trypsin in a concentration of 1 : 30,000 as an activator. Crystalline preparations from schizophrenics under the same conditions gave positive reactions, the reaction with cerebral cortex being strong. It is concluded that the crystalline material is not (I), but that (I), when present, is adsorbed on the crystals. A crystalline preparation with (I) activity was obtained from the urine of a patient with Huntington's chorea as follows: 8 l. of urine was dried, 1 gm. of the powder was eluted at 37° with 40 ml. of water, and from this solution crystals separated in the icebox. The preparation had strong (I) activity even without trypsin activation against various parts of the brain. A crystalline preparation from C.S.F. of the same patient was also active against some but not all of the substrates. The untreated urine and C.S.F. from several hundred patients were tested for (I) activity against various parts of the brain as substrates. The C.S.F. results correlated more closely with the clinical diagnoses than the urine findings.

WARREN M. SPERRY (Chem. Abstr.).

The Effect of Spinal Puncture and of Subarachnoid Introduction of Tri-iodide on Blood Sugar in Man. Pappalardo, Piero (Univ. Catania, Italy). [Riv. patol. nervosa e Mentale, **62**, 93-107 (1943).]

The effect on blood-sugar concentration (I) of removal of 8 c.c. of cerebrospinal fluid (C.S.F.), with and without the subarachnoid injection of tri-iodide (II) and of (II) without withdrawal of C.S.F. was studied in patients with various neurological and mental diseases. (I) was determined before and at 1/2, 1, 3, 5 and 7 hours after the experimental procedure. After removal of C.S.F. alone in 15 patients there was an average decrease in (I) of about 20 per cent. at 1 hour with a slow increase toward normal, but the average (I) was still 10 per cent. low at 7 hours. There was a wide variation in degree of change in (I), more or less related to the severity of neurological symptoms. When (II) was injected after removal of C.S.F.

in 12 experiments (I) increased in some and decreased in others, so the average (I) did not change significantly. In all of 5 experiments on 3 patients (I) increased after injection of (II) without withdrawal of C.S.F., with the maximum increase (about 30 per cent.) at 1 hour.

WARREN M. SPERRY (Chem. Abstr.).

The Effect of Ether and Dial Anesthesia on the Passage of Sulfathiazole into the Cerebrospinal Fluid. Teague, R. S., and Perdue, Mervin (Med. Coll. of Alabama, Birmingham). [J. Pharmacol. Exptl. Therap., **92**, 277-82 (1948).]

Ether anesthesia significantly increased the passage of sulfathiazole from the blood into the cerebrospinal fluid of dogs. The influence of dial anesthesia was relatively slight. The findings are discussed from the standpoint of the influence of changes in the cerebral circulation.

L. E. GILSON (Chem. Abstr.).

Hormone Activity of Human Cerebrospinal Fluid. Cavini, Augusto (Neuropathol. Clinic, Milan, Italy). [Riv. patol. nervosa e mentale, **62**, 320-60 (1943).]

In most of 55 patients with neurological or mental diseases oxytocin (I) activity was found in the cerebrospinal fluid (CSF) by a modified guinea-pig uterus method, but the amounts were small and bore no relation to the type of disease. The injection of CSF directly into the thorax of guinea-pigs caused a decrease in number of pulsations of the heart and the disappearance of the post-diastolic pause. CSF also caused irregular contractions of the isolated guinea-pig bladder. These results indicate that pitressin was present and active while (I) was inactive. No evidence was found for the presence of CSF of hormones of the middle and anterior lobes of the pituitary.

WARREN M. SPERRY (Chem. Abstr.).

Potassium and Calcium in Blood Serum and in Spinal Fluid in Causalgia. Kolo-tilova, A. I. (Leningrad Univ.). [Nauch. Byull. Leningrad. Gosudarst. Ordena Lenina Univ., No. 2, 10-12 (1945).]

The object of the experiments was to evaluate the functional state of the sympathetic nervous system by changes in the contents of K and Ca in blood serum resulting from subcutaneous injection of adrenaline to wounded causalgia patients. The content of K in the blood serum remained within normal limits after the injection of adrenaline in amounts smaller than 1 c.c. of 1:1000. Similar results were obtained with respect to Ca in most cases, although in some individual cases the Ca content was slightly higher. The K:Ca blood coefficient in these patients was slightly lower (below 1.5). The contents of K and Ca in the spinal fluid remained normal in all cases. Administration of higher concentrations of adrenaline (1 c.c. of 1:1000) decreased the K content in the blood in all cases 45 minutes after injection by approximately 20 per cent., whereas Ca remained unchanged.

W. R. HENN (Chem. Abstr.).

Application of the Weichselbaum Biuret Reagent to the Determination of Spinal Fluid Protein. Ditterbrandt, Marlowe (Clin. Lab., Portland, Ore.). [Am. J. Clin. Path., **18**, 439-41 (1948).]

Mix 1 c.c. of spinal fluid and 1 c.c. of biuret reagent (C. A., **40**, 3789⁸) in a Kahn tube. In a control tube place 1 c.c. of biuret reagent and 1 c.c. of water. Place them in a water bath at 37° for 30 minutes. Read immediately in a spectrophotometer. Calculate the concentration by multiplying the optical density by the factor K. K can be calculated after the preparation of the optical d.-concentration graph from the formula $K = C/D$, where C is the concentration of a known sample and D the optical d. The method is rapid and accurate.

JOHN T. MYERS (Chem. Abstr.).

Methods for Determining Total Proteins and Their Fractions in Spinal Fluid. Bau-douin, A., Lewin, J., and Hillion, P. [Ann. biol. clin. (Paris), **6**, 12-37 (1948).]

Review covering these topics: Qualitative assays; semiquantitative assays; exact quantitative assays; chemical methods; fractionation by ultracentrifugation, ultrafiltration, electrophoresis, and chemical precipitation. Of all the methods,

fractionation by $(\text{NH}_4)_2\text{SO}_4$ seemed particularly to be recommended, for it permits a quantitative separation of fractions even in very dilute solutions, is simple, and needs no special apparatus.

DOROTHY A. MEYER (Chem. Abstr.).

Influence on the Vasomotor System of Simultaneous Modifications of the Concentration of Potassium and Calcium Ions in the Liquid of the Cerebral Ventricles. Leusen, I. (Univ. Gand., Belg.). [Experientia, **4**, 154-5 (1948) (in French).]

In dogs sensitized with morphine-chloralalose, liquid was introduced into a lateral ventricle by needle and allowed to flow out of a needle in the cisterna magna. An excess of K in the ventricles increases the vasomotor tonus and the vasomotor responses produced by faradization of the central end of the vagus in the neck, or by changing pressure in the isolated carotid sinuses. An excess of Ca depresses the tonus of the vasomotor center and its reflex responses. An excess of Ca may be neutralized by an excess of K. Perfusion with a solution containing no Ca increases the tonus and the responses of the vasomotor center, while the absence of K does not seem to have any influence.

JOHN T. MYERS (Chem. Abstr.).

Content of Bisulfite-binding Compounds in the Blood and the Spinal Fluid in Acute Neuroinfectious Processes (in Relation to the Content of Vitamin B₁ in the Blood and the Spinal Fluid in Neuroinfections). Kravets, V. S., and Rabinovich, S. M. [Neuropatol. i Psikhiat., **17**, 59-63 (1948).]

In 100 per cent. of spinal fluids studied and 92 per cent. of bloods studied the content of bisulfite-binding substances was sharply increased over normal level in acute stages of various neuroinfections. This indicates a decrease of content or of activity of vitamin B₁ in the organism. The principal bisulfite-binding compound was pyruvic acid, which normally exists in the blood to the extent of only 8-10 mgm. per cent. The method used is not stated. The average increase of blood pyruvic acid was to 35 mgm. per cent. (i.e. 360 per cent. increase), with maximum 1,500 per cent. increase being observed in a grave case of acute infection of the brain and the spinal cord. Disseminated sclerosis gave an average increase of 410 per cent., maximum 580 per cent.; somewhat lower values were found in acute polyneuritis of infectious nature. Increases in the spinal fluid averaged 520 per cent. for polyneuritis and 610 per cent. for encephalomyelopolyneuritis; maximum 900 and 910 per cent. respectively.

G. M. KOSOLAPOFF (Chem. Abstr.).

Free Amino Acids with Benzene and Benzopyrrole Nuclei in the Spinal Fluid of Schizophrenics and Depressives. Tinelli, Giuseppe (Univ. Bari, Italy). [Boll. soc. ital. biol. sper., **23**, 981-2 (1947); cf. C. A., **40**, 6629⁴.]

In 51 such cases the average titer of the above amino acids (Mitolo semimicro-method (C. A., **41**, 2769h)) was 3.27 mgm./100 c.c.

HELEN LEE GRUEHL (Chem. Abstr.).

Free Amino Acids with Benzene and Benzopyrrole Nuclei in the Spinal Fluid of Phrenasthenics. Tinelli, Giuseppe (Univ. Bari, Italy). [Boll. soc. ital. biol. sper., **23**, 982 (1947); cf. C. A., **40**, 6629⁴.]

The average titer of these amino acids was 2.78 mgm./100 c.c. fluid in 52 cases.

HELEN LEE GRUEHL (Chem. Abstr.).

Plasma and Cerebrospinal Fluid Iron Concentration Studies in Syphilitic and Non-syphilitic Patients. Greif, Roger L. (Johns Hopkins Univ., Baltimore, Md.). [Am. J. Syphilis, Gonorrhea, Venereal Diseases, **32**, 337-44 (1948).]

Plasma Fe concentrations were measured after oral administration of FeSO_4 to patients with syphilis, anemia and chronic infections. No diagnostic or prognostic value could be attached to the tolerance curves in syphilitics, and no correlation was noted between pathological changes and Fe concentrations of the cerebrospinal fluid. The mean Fe concentrations of 4 normal and 4 rabbits with testicular chancres were 261 and 225γ/100 ml. respectively.

A. DIETZ (Chem. Abstr.).

Action of Acetylcholine and Adrenaline on the Reflex Stimulation of the Isolated Spinal Cord of a Frog. Kirillova, A. A. [Byull. Eksptl. Biol. Med., **24**, No. 1, 75 (1947); cf. C. A., **41**, 4576i.]

The object of this investigation was the study of the action of physiologically active substances directly on the nerve centers. Low concentrations of acetylcholine (2×10^{-8} to 5×10^{-8}) strengthen the reflex activity of the central nervous system, and high concentrations (1×10^{-6}) suppress it. Tests showed the presence of sufficient acetylcholine in the central nervous system to cause a change in the physiological action and in the functional state of nerve centers. Also adrenaline (0.1 per cent.) causes stimulation of spinal nerve centers, especially when added to Ringer solution.

W. R. EICHLER (Chem. Abstr.).

The Chemical Nature of a Substance in Brain Tissue Sensitizing Muscle to Acetylcholine. Golubtsova, A. V., and Mineav, P. F. [Byull. Eksptl. Biol. Med., **23**, 169-72 (1947).]

Brain emulsion of a frog was prepared. Eleven experiments were carried out to determine the sensitizing action (1) of a plain emulsion, (2) of emulsion boiled for 7 minutes in neutral solution, (3) of the filtrate after precipitation of the proteins, and (4) of the same filtrate after 7 minutes' boiling with an equal volume of 2 N HCl, on stomach muscle of a frog. Exposure to acetylcholine with unboiled, but especially with boiled emulsion caused greater contraction of the muscle than with acetylcholine alone. Emulsion alone did not cause contraction. The sensitizing substance is thermostable in neutral medium. The sensitizing effect is not lost by precipitation of protein from the emulsion with trichloroacetic acid. Boiling protein-free filtrate with HCl causes loss of the sensitizing action and splitting of compounds containing labile phosphate groups present in the brain. Inorganic P in the protein-free filtrate increased with HCl hydrolysis about 22-30 mgm., calculated with respect to 100 gm. brain tissue. It is assumed that the sensitizing substance in brain tissue is a compound containing labile phosphate groups. It is possible that the sensitizing action is caused not only by adenosine-triphosphoric acid and adenosinetriphosphate of brain origin, but also by polyphosphoric compounds in brain tissue, especially diphosphothiamine.

W. R. EICHLER (Chem. Abstr.).

Effect of Acetylcholine, Caffeine and Alkaloids on Activity of Muscle Adenosinetriphosphatase. Torda, Clara, and Wolff, Harold G. (Cornell Univ. Med. Coll., New York, N.Y.). [Am. J. Physiol., **152**, 86-92 (1948).]

The effects of acetylcholine, some alkaloids and caffeine on the activity of muscle adenosinetriphosphatase were investigated. Acetylcholine in low concentrations increased the activity of the enzyme. d-Tubocurarine, caffeine and K, in concentrations corresponding to those inducing muscle contracture, decreased the activity of the enzyme. Atropine, ephedrine, morphine, physostigmine, prostigmine, quinine, strychnine, and veratrine, in concentrations not interfering with the P determination, did not modify the activity of the adenosinetriphosphatase. The mechanism of action of acetylcholine on muscle is discussed.

E. D. WALTER (Chem. Abstr.).

The Bathmotropic Effect of Acetylcholine on the Heart. Leonova, E. F. [Byull. Eksptl. Biol. Med., **23**, 278-81 (1947) (in Russian).]

Excitability of heart muscle is increased by acetylcholine and rhythm of the sinus node is decreased. A definite relation exists between the decrease in the stimulation of the sinus node caused by acetylcholine and its negative chronotropic action. The clearer the negative chronotropic effect caused by acetylcholine the weaker the stimulation of the sinus node. After atropinization of the heart acetylcholine no longer lessens the stimulation of the sinus node, but the power of acetylcholine of increasing the stimulation of the heart muscle is maintained. This circumstance shows that the increase in the stimulation of the heart muscle by acetylcholine is not caused by the muscarine-like action of acetylcholine. Acetylcholine has the same effect on the heart muscle as on skeletal muscles, increasing the stimu-

lation of both. A cardiogram of a frog's heart and a table showing injection of acetylcholine of different concentrations as well as the state of the heart activity are shown.

W. R. EICHLER (Chem. Abstr.).

Action of Acetylcholine on the Blood Sugar in Dogs. Onchi, Takeyuki (Tohoku Imp. Univ., Sendai). [Tohoku J. Exptl. Med., **41**, 102-7 (1941) (in English).]

A 2.5 per cent. solution of acetylcholine chloride was injected subcutaneously into 3 normal dogs, or 3 doubly splanchnicotomized dogs, at a concentration of 15 mgm. per kgm. body weight. The dogs were not restrained or narcotized. The blood sugar in the normal dogs increased from 96, 75 and 72 to 153, 120 and 87 mgm. per cent. respectively, the maximum value occurring about a half hour after injection. About 1-1½ hours later the blood-sugar levels were again normal. In the splanchnicotomized dogs the blood sugar also increased from 96, 76 and 71 to 140, 126 and 103 mgm. per cent. respectively, 15, 30 and 10 minutes after acetylcholine injections. Intravenous injections of 3 mgm. of acetylcholine chloride per kgm. of body weight also acts to cause hyperglycemia, its intensity depending upon the velocity of injection. However, 0.5 mgm. of acetylcholine chloride per kgm. body weight injected intravenously in 30 seconds decreased the blood-sugar content. Consequently, acetylcholine hyperglycemia does not depend upon the functioning of the splanchnic nerves.

BRUNO VASSEL (Chem. Abstr.).

Comparative Study of the Acetylcholine Content and the System Histidine Decarboxylase-histaminase in Nerves During Stimulation. Rybkina, D. E. [Byull. Eksptl. Biol. Med., **24**, No. 1, 53-7 (1947).]

The sciatic, phrenic and vagus nerves of several animals were stimulated by means of an induction coil. The acetylcholine content in nerve fibres increases at the threshold stimulation, but decreases or entirely disappears with stronger stimulation. Threshold stimulation of nerves for one minute causes liberation of histamine and activation of histidine decarboxylase. Strong stimulation increases histamine liberation from the nerves.

W. R. EICHLER (Chem. Abstr.).

Interaction Between Acetylcholine and Adenosinetriphosphate in Normal, Curarized, and Denervated Muscle. Buchthal, Fritz, and Folkow, Bjorn (Univ. Copenhagen, Denmark). [Acta Physiol. Scand., **15**, 150-60 (1948).]

Adenosinetriphosphate (ATP) applied to muscle increases its sensitivity towards intra-arterially injected acetylcholine 4-10 fold. Inorganic triphosphate has a similar effect. The effect is not on the neuromuscular transmission, but on the muscular substance, since it is elicited also in a curarized muscle. However, the electrically induced increase is restricted to the period of contraction. In denervated muscle intra-arterial injection of acetylcholine makes the muscle insensitive to the application of ATP. The blocking action of acetylcholine on subsequent intra-arterial injection of ATP into denervated or curarized muscles occurs in two stages, according to the amount injected. Why small amounts of acetylcholine prevent ATP administered through the artery from producing a response is not clear. Large amounts also inhibit the release of contraction by intramuscularly applied ATP. Since, however, the electric excitability is retained, it must be assumed that acetylcholine somehow prevents a contact between ATP and the contractile muscle elements. The threshold for intra-arterially injected acetylcholine was found to be 10 times higher in winter frogs than in summer frogs. In winter frogs acetylcholine produces a contracture-like response, and a previous ATP application changes it to a contraction of short duration. Twitches produced by electric stimulation during acetylcholine response are of smaller height in winter frogs and of greater height in summer frogs. The decreased electric excitability and the changes in the strength duration curve of muscle persists for a considerable time after the intra-arterial injection of acetylcholine, especially in denervated muscles. Denervated muscle manifests considerably higher electric excitability than curarized muscle, but the strength-duration curve of denervated muscles is unaffected by curarization, and previous application of ATP does not influence the strength-duration curve of a muscle.

S. MORGULIS (Chem. Abstr.).

Inhibitory Action of Antergan on Acetylcholine and Histamine. Danielopolu, D., Popesco, M., and Mezincesco, E. [*J. physiol. et path. gen.*, **38**, 316-27 (1941-1945).]

The substance 933F prevents the action of adrenaline in small concentrations, of acetylcholine in much higher concentrations, and of histamine only in very high concentrations. Antergan (2399RP) has no action on adrenaline, but inhibits acetylcholine and histamine action on the intestine and pregnant uterus of the guinea-pig. It has a hypotensive effect itself, and does not prevent the action of acetylcholine and histamine on the blood pressure and circulation, but does so in conjunction with atropine. Therapeutically in anaphylactic shock both should be given, since, after atropine, acetylcholine and histamine cause adrenaline secretion from the adrenals.

B. A. (Chem. Abstr.).

Blood-pressure Changes in Response to Electrical and Chemical (Acetyl- β -methylcholine) Stimulation of the Cerebral Cortex in Dogs. Kremer, William F. (Univ. of Virginia, Charlottesville). [*Am. J. Physiol.*, **152**, 314-23 (1948).]

Acetyl- β -methylcholine evoked a clear response from two circumscribed cortical areas in dogs, one in the motor cortex, the other in the anterior ectosylvian gyrus. Simultaneous application of prostigmine prolonged the effect considerably. The use of Na amytal as a general anesthetic, instead of dial, affected only the stimulability of the cortex, but did not change the character of the blood-pressure response. Acetyl- β -methylcholine is considered a useful cortical stimulant, since it probably approaches the ideal physiological stimulus more than does electric faradic stimulation.

E. D. WALTER (Chem. Abstr.).

Local Anesthetics and Cholinesterase. Ferrari, William (Univ. Modena, Italy). [*Boll. soc. med. chir. Modena*, **45**, 422-7 (1945).]

Experiments *in vitro* with human (and horse) blood serum and brain extracts showed that some local anesthetics as novocaine, percaïne, cocaine and tutocaine inhibit the cholinesterase of blood and not that of the nervous tissue. This explains why local anesthetics do not act on the whole organism as does eserine.

C. SCANDURA (Chem. Abstr.).

A Study of the Cholinesterase of the Blood and of the Cerebrospinal Fluid in Different Psychiatric Syndromes. Mutrux, S., and Glasson, B. (Bel-Air, Geneva, Switz.). [*Monatsschr. Psychiat. Neurol.*, **114**, 20-35 (1947) (in French).]

In 100 patients with various types of psychiatric disorder there was a 10-fold variation in serum pseudocholinesterase and a 3-fold variation in red-cell cholinesterase; there was no correlation between the amounts of these enzymes. Very small and variable amounts of cholinesterase, pseudocholinesterase and aliesterase were found in the cerebrospinal fluid. There was no correlation between any of the variables determined and any psychiatric disorder.

WARREN M. SPERRY (Chem. Abstr.).

The Cholinesterase of Human Cerebrospinal Fluid. Ferrari, William (Univ. Modena, Italy). [*Boll. soc. med. chir. Modena*, **46**, 2 pp. (1946).]

In a preceding study (*cf.* preceding abstract) the cholinesterase of brain extracts is different from that of blood. Now it is stated that in cerebrospinal fluid both types of cholinesterase are represented, as eucupine inhibits only partly (60 per cent.) the activity of cholinesterase.

C. SCANDURA (Chem. Abstr.).

Eucupine Action on Cholinesterase. Zamboni, P. (Univ. Modena, Italy), and Ferrari, W. [*Boll. soc. med. chir. Modena*, **45**, 435-45 (1945).]

The action of eucupine on the cholinesterase of horse serum and human serum and on the cholinesterase of horse-brain extracts was investigated and compared with that of eserine. Eucupine is found to be more active than eserine in horse serum, active enough in human serum, but inactive in horse-brain extracts. The cholinesterase of brain extracts is different from that of blood.

C. SCANDURA (Chem. Abstr.).

Cholinesterase. V. Kinetics of the Enzyme Inhibition. Nachmansohn, David, Rothenberg, Mortimer A., and Feld, Emily A. (Columbia Univ., New York, N.Y.). [*J. Biol. Chem.*, **174**, 247-56 (1948); cf. *C. A.*, **42**, 2025f.]

Cholinesterase (I) was prepared by $(\text{NH}_4)_2\text{SO}_4$ precipitation. Lyophilization and storage for several months in the icebox had no effect on the activity of (I). It was purified by ultracentrifugation. In the (I) solution obtained 1 mgm. of protein split about 60 gm. of acetylcholine per hour. About 50 per cent. of (I) was inactivated by di-isopropyl fluorophosphate (II) after 150 minutes' incubation. There was little difference in the rates of inactivation between 10° and 23° . With increased (II) concentration the inactivation of (I) increased proportionally, which suggests a reaction on a stoichiometric basis. The greater the dilution of (I) the higher the excess of (II) required. The main difference of the inhibition of (I) by (II) as compared with that of prostigmine and eserine is the irreversibility of (II). Incubation up to 150 minutes did not affect the inhibitory action of the alkaloids. In lower concentration the alkaloids have a stronger effect than (II), but in higher concentration (II) is more effective and rapidly approaches completion. The toxicity of (II) must be attributed solely to the inactivation of (I), and the great variety of toxic symptoms is due to the great number of variables influencing the course of this single reaction.

H. O. SINGER (Chem. Abstr.).

The True Cholinesterase and Pseudocholinesterase. Their Differentiation by Action of a Local Anesthetic. Ferrari, W. (Univ. Modène, Italy). [*Schweiz. med. Wochschr.*, **78**, 282-4 (1948); cf. *C. A.*, **42**, 3446f.]

Caffeine inhibits cholinesterase activity of brain extracts and of extracts of the sciatic nerve. It has no effect on the activity of the cholinesterase of human serum and of horse serum. A differentiation of the two types of enzymes by the inhibitory action of caffeine is not possible. Ferrari suggests the use of eucupine.

GERTRUDE E. PERLMANN (Chem. Abstr.).

Cholinesterase: A Study in Comparative Enzymology. Augustinsson, Klas Bertil (Roy. Veterinary Coll., Stockholm). [*Acta Physiol. Scand.*, **15**, Suppl. 52, 182 pp. (1948); cf. *C. A.*, **41**, 4841b.]

The unfertilized sea urchin egg is free from cholinesterase activity, but 20 hours after fertilization this activity suddenly increases progressively to a high value at 48 hours. The unfertilized eggs hydrolyze tributyrin, acetylsalicylic acid or acetyl-salicylcholine by ordinary esterase action. The cholinesterase, when it appears, acts on both acetylcholine or acetyl- β -methylcholine. Bee venom inhibits cholinesterase (horse serum), but has no cholinesterase activity. The kinetics of the reaction and the relation of activity to substrate concentration are discussed. Physostigmine is a strong inhibitor of cholinesterase at all substrate concentrations, and its effect on other esters is also discussed. KCl has only slight inhibiting action. Clupeine inhibits competitively. Choline likewise inhibits competitively in certain instances. Methylene blue inhibits strongly all cholinesterase activity; caffeine and neurine exert a differential inhibition. The cholinesterases are regarded as a family of related enzymes, but of widely divergent properties, which at optimum conditions hydrolyze acetylcholine at the highest rate. Group I embraces the enzymes, whose activity is inhibited by a high acetylcholine concentration (optimum substrate concentration 3×10^{-3} M), while Group II contains those with maximum activity at infinite substrate concentration, but in neither group is the specificity for choline esters absolute.

S. MORGULIS (Chem. Abstr.).

Influence of Central Nervous System Stimulants on Cholinesterase. Myazdrikova, A. A. (Med. Inst. I Order of Lenin, Moscow). [*Farmakol. i Toksikol.*, **10**, No. 3, 3-6 (1947).]

Solutions of caffeine-NaOBz (I) 200, strychnine nitrate (II) 20, 100, and 250, and phenamine sulfate (III) 100 p.p.m. do not contract leech muscle (IV) nor affect the activity of acetylcholine (V) or eserine (VI) toward (IV); but (III) contracts (IV) at 1,000 p.p.m. The effect of mixed (V) and (VI) on (IV) is accelerated by (I). Metrazole contracts eserine (IV) at 1,000, cordiamine is less active at 1,000 and 2,000 p.p.m. Subsequent doses of (V) or (VI) (at 1 p.p.m.) affect (IV) more than

does the initial dose. The ternary mixture (I), (V), (VI) was active; blends of (V) and (VI) were very active, blends of (I) and (VI) inert to (IV).

JULIAN F. SMITH (Chem. Abstr.).

Influence of Parenteral Treatment on Cholinesterase in Gastric Ulcer. Demole, M., Aron, E., and Pequet, J. (Univ. Geneva, Switz.) [*Gastroenterologia*, **71**, 273-82 (1946).]

Injectations of histidine plus vitamin C caused an increase of serum cholinesterase; injection of histidine alone, or of sex hormones, caused a decrease of serum cholinesterase.

M. H. POWER (Chem. Abstr.).

Selective Inhibition of Cholinesterases. Adams, D. H., and Thompson, R. H. S. (Dept. Biochem. Oxford, Eng.). [*Biochem. J.*, **42**, 170-5 (1948).]

"True" cholinesterases hydrolyze readily acetyl- β -methylcholine, but not benzoylcholine, while the reverse holds for the pseudo enzyme. A selective inhibitor of the pseudo enzyme has been demonstrated in certain curare preparations. An inhibitor which is specific for true cholinesterase but is relatively ineffective for the pseudo enzyme is apparently not yet known, though caffeine comes near being one (6 mM is required to cause 40 per cent. inhibition of splitting of 6.6 mM acetylcholine). The following three types of inhibitors have been described: (a) Selective inhibitors of true cholinesterase (N-methylamine-2,2'-dichlorodiethyl (DDM) (I) and caffeine; (b) selective inhibitors for pseudocholinesterase (alkyl fluophosphates, Nu 683, curare (unauthenticated samples), percaïne and pyrazolone derivatives); (c) inhibitors of both cholinesterases (eserine, tri-o-cresyl phosphate and morphine). These studies indicate that (I) fulfils the role of a selective inhibitor of the true cholinesterases. It is less potent than either di-isopropyl fluo-phosphate or eserine, but DDM may not necessarily be the most potent representative of the N mustard group. However, 2.5 to 8.7×10^{-5} M causes 50 per cent. inhibition, whereas 10-30 times as high a concentration is required to inhibit to the same extent the pseudo enzymes.

S. MORGULIS (Chem. Abstr.).

Cholesterase and Lecithinase of Blood Plasma. Breton, Elaine Le, and Pantaléon, Jean (Sorbonne, Paris). [*Arch. sci. physiol.*, **1**, 199-217 (1947) (in French); cf. *C. A.*, **39**, 3796⁸; **42**, 2296e, 2659d.]

The ratio free cholesterol/esterified cholesterol in the serum or plasma of mammals is constant. The constancy of the ratio is due to two associated enzymes, a β -lecithinase and Sperry's cholesterase. The esterification takes place in the β -lecithinase

following two steps; lecithin + $2\text{H}_2\text{O}$ $\xrightarrow{\hspace{1cm}}$ 2 fatty acids + glycerophos-

phate of choline; 2 fatty acids + 2 cholesterol $\xrightarrow{\hspace{1cm}}$ 2 cholesterolesters +

2 H_2O . Phlorizin, which inhibits the lecithinase reaction, also inhibits the formation of cholesterol esters.

W. T. SMITH, jun. (Chem. Abstr.).

3. Pharmacology and Treatment.

Dangers and Advantages of Insulin Therapy. Neri, Antonio (Univ. Milan, Italy). [*Riv. patol. nervosa e mentale*, **61**, 137-251 (1943).]

Review concerned mainly with chemical and physiological studies of perspiration, saliva, gastric secretion, bile, liver and kidney function, and internal secretions (thyroid, parathyroid, pituitary, adrenal, pancreas, gonads) following insulin treatment.

WARREN M. SPERRY (Chem. Abstr.).

Studies on the Mechanism of the Central Action of Hexachlorocyclohexane and of Dibenzylmethylamine on the Higher Animals. Dallemagne, M. J., Philippot, E., and Gernay, J. M. (Univ. Liège, Belg.). [*Experientia*, **4**, 155 (1948) (in French).]

Experimental results show that the γ -isomers of hexachlorocyclohexane injected intravenously into dogs produce severe convulsions, but that the α -, β - and δ -

isomers do not have this effect. The action of the γ -isomers seems to involve the activity of cholinesterase. Similar results were obtained with dibenzylmethyamine, which produces hypermotor activity and is a powerful inhibitor of pseudocholinesterase activity *in vitro*. This is not the case with the γ -isomer of hexachlorocyclohexane.

JOHN T. MYERS (Chem. Abstr.).

Anticonvulsant Action of Isopropyl Alcohol. Chu, Nai, Driver, R. L., and Hanzlik, P. J. (Stanford Univ. Med. School, San Francisco, Calif.). [*J. Pharmacol. Exptl. Therap.*, **92**, 291-302 (1948).]

Isopropyl alcohol (I) given gastrically to rabbits, cats and rats was found to be anticonvulsant against clonic (epileptiform) convulsions produced electrically. It compared favorably with diphenylhydantoin (II), and was less objectionable than phenobarbital and superior to tridione. High anticonvulsant efficiency was preserved, without motor depression and ataxia, when (I) was given with (II), but not when given with phenobarbital or tridione. (I) alone or with (II) was comparatively safe in the single optimum doses used (1,250 mgm./kgm.); all the animals recovered uneventfully and survived indefinitely. Higher doses were toxic. (I) caused a definite acetoneemia which is believed to be largely responsible for, or intimately related to, its anticonvulsant action, although the average peak changes in blood acetone and cortical thresholds did not coincide. Maximum cortical depression occurred about one hour after administration of (I) and maximum blood acetone in 2-4 hours. The anticonvulsant efficiency of (I), as a ketogen, is consistent with the well-known ketogenic principle in therapy of epilepsy. Thus far (I) has been found to be the most efficient and least objectionable of a considerable number of ketogenic compounds tested.

L. E. GILSON (Chem. Abstr.).

Studies of Analeptics. II. Metrazole. Whitehead, R. W., and Draper, W. B. [*Surg. Gynecol. Obstet.*, **74**, 1020-4 (1942); cf. *C. A.*, **37**, 4477⁶.]

In dogs metrazole (5 mgm. per kgm.) slightly increased the amounts of ether or divinyl ether, but not of CHCl_3 , needed to produce respiratory arrest. Failures to resuscitate dogs from overdoses of ether, divinyl ether or CHCl_3 by means of artificial respiration and O were 1.4, 3.7 and 9.7 per cent. respectively. There were no failures when metrazole was injected as well.

B. A. (Chem. Abstr.).

The Reaction Between Thiobarbituric Acid and the Oxidation Products of Certain Lipides. Bernheim, Frederick, Bernheim, Mary L. C., and Wilbur, Karl M. (Duke Univ. School of Med., Durham, N.C.). [*J. Biol. Chem.*, **174**, 257-64 (1948); cf. *C. A.*, **42**, 3008i.]

After incubation with ascorbic acid, egg lecithin, the fatty acids isolated from it, brain lecithin, fatty acids from linseed oil, cephalin, methyl linolenate, and a brain protein-lecithin complex give color reactions with either thiobarbituric (I) or p-aminobenzoic acid (II). The absorption spectra of these colors are identical with those described by Kohn and Liversedge (*C. A.*, **39**, 1208³) for the condensation products of (I) and (II) with aerobically incubated tissues. The same colors are produced after autoxidation. Thus ascorbic acid is acting as a catalyst. Crystallized hemoglobin acts catalytically for all lipides except cephalin. Incubation with H_2O_2 gives negative results. Lysolecithin, sphingomyelin and sphingosine do not give the reaction. The addition of iodine before incubation, semicarbazide, or phenylhydrazine after incubation reduces the amount of color. The color compound was isolated, analyzed and found to contain atom fragments resulting from the oxidation of a double bond in linolenic and similar unsaturated acids, which may be formed in oxidative metabolism.

A. DIETZ (Chem. Abstr.).

Respiratory, Electroencephalographic and Blood Gas Changes in Progressive Barbiturate Narcosis in Dogs. Swank, Roy L., and Foley, Joseph M. (Harvard Med. School, Boston). [*J. Pharmacol. Exptl. Therap.*, **92**, 381-96 (1948).]

Experimental data on the action of Na amytal are presented as graphs. Consistent correlations were observed which indicated the relative depth of narcosis with fair accuracy. The maintenance of normal O tension in the arterial blood

appears to lessen the depression of neuronal activity by Na amytal. The effects of analeptics (picrotoxin, metrazole, caffeine, aminophyllin and benzedrine) were determined at different depths of narcosis. L. E. GILSON (Chem. Abstr.).

Determination of Barbiturates in Urine. Lovero, Giacomo (Univ. Naples). [*Folia Med. (Naples)*, **31**, 106-14 (1948).]

Mix 20 c.c. of the urine with 50 gm. anhydrated Na_2SO_4 , and put into an extinguishing tube provided at the bottom with a layer of 1 gm. active charcoal and 1 gm. MgO . Percolate with Et_2O and collect the passing liquid in a test-tube heated with steam to evaporate the Et_2O as it passes. Identify barbiturates in the residue of the Et_2O with $\text{Co}(\text{NO}_3)_2$ (20 drops 0.3 per cent. in EtOH) and 10 drops of 50 per cent. NH_3 in EtOH . A blue color indicates barbiturate. The reaction is sensitive to 0.1 mgm. A. E. MEYER (Chem. Abstr.).

The Analgesic and Hypnotic Actions of Barbiturates. Hart, E. Ross, and Weaver, O. M., jun. (Jefferson Med. Coll., Philadelphia, Pa.) [*Anesthesiology*, **9**, 276-80 (1948).]

The ability of various doses of four representative barbiturates (Na phenobarbital, Na pentobarbital (nembutal), Na seconal, Na thiopental (Na pentothal)) to produce analgesia and hypnosis was studied in rats. These drugs produce their depressant effects (hypnosis) without altering the pain threshold at least as often as they produce a significant rise in pain threshold (analgesia). The incidence of analgesia following administration of barbiturates does not seem to be related to dosage, nor does there appear to be any real difference between the various members of the group in this respect. Barbiturates cannot be relied upon to reduce sensitivity to pain. RUTH BERGGREN (Chem. Abstr.).

Study of the Mechanism of Narcosis by Non-specific Narcotics. Dode, M., Gavaudan, P., and Poussel, H. [*Mem. services chim. etat. (Paris)*, **32**, 388-409 (1945).]

A narcotic is defined as a substance capable of inhibiting a certain activity of a living cell which is essential to proper functioning. Chromosomic contraction is probably a result of modification of the cellular medium, or an irregularity of the chronology of various phenomena which is contrary to the theory of Ostergren (*Hereditas*, **30**, 439-467 (1944)), that it is a case of the bending of the protein chain under direct action of a narcotic. The narcosis produced by non-specific narcotics is due to a precipitation of a part of the lipoids found associated with the lipophilic chains of the proteins and the lipoprotein synapses. The lipophilic formation of droplets of oil, which resemble the separation of two phases and which is induced by a number of non-specific narcotics used in elevated and toxic doses, is due to the cytoplasmic action of these substances. The theory is based on the hypothesis that the lipoids of the lipoprotein synapses can be considered to be dissolved in the lipophilic chains of the protein molecule. It is possible that this representation does not agree exactly with reality, and that the lipoids might be adsorbed on the lipophilic chain of the proteins. Thermodynamically the two are difficult to distinguish. It is easily possible that the narcotic produces a displacement of the adsorbed lipid, which then leads to a mixed lipoidal narcotic precipitate. Since the precipitate formed has a constant composition, it follows that all the non-specific narcotics should be adsorbed by the lipophilic chains of the proteins in order to obtain a similar thermodynamic activity. The two theories of adsorption and of lipid solubility which have heretofore been considered opposed have been found to have a common basis. The narcosis produced in both cases at the moment of precipitation of cellular lipoids dissolved or adsorbed on the lipoprotein synapses attains a limiting critical value. H. O. S. (Chem. Abstr.).

